Hackmatack National Wildlife Refuge

Water Resource Inventory and Assessment (WRIA) Summary Report

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U.S. Department of the Interior
Fish and Wildlife Service
Region 3 (Midwest Region)
Division of Natural Resources and Conservation Planning;
Bloomington, MN

The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

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Author's Note:

There are embedded links throughout this document within the table of contents and indicated by underlined text. A database of the presented data, additional data, documents and the referenced studies will be available as part of a digital document library housed on the Environmental Conservation Online System (ECOS). Geospatial data layers were obtained from USGS The National Map (TNM), the State of Illinois, the State of Indiana and Refuge Staff.

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Chapter 1: Executive Summary

The Water Resource Inventory and Assessment (WRIA) is a reconnaissance-level effort, which provides:

- Descriptions of local soils, topography, and natural setting information
- Historic, current, and projected climate information, including hydroclimate trends
- An inventory of surface water and groundwater resource features
- An inventory of relevant infrastructure and water control structures
- Summaries of historical and current water resource monitoring, including descriptions of datasets for applicable monitoring sites
- Brief water quality assessments for relevant water resources
- A summary of state water laws
- A compilation of main findings and recommendations for the future

The WRIA provides inventories and assessments of water rights, water quantity, water quality, water management, climate, and other water resource issues for each Refuge. The long-term goal of the National Wildlife Refuge System (NWRS) WRIA effort is to provide up-to-date, accurate data on Refuge System water quantity and quality in order to acquire, manage, and protect adequate supplies of water. Achieving a greater understanding of existing information related to Refuge water resources will help identify potential threats to those resources and provide a basis for recommendations to field and Regional Office staff. Through an examination of previous patterns of temperature and precipitation, and an evaluation of forward-looking climate models, the U.S. Fish and Wildlife Service (USFWS) aims to address the effects of global climate change and the potential implications on habitat and wildlife management goals for a specific Refuge.

WRIAs have been recognized as an important part of the NWRS Inventory and Monitoring (I&M) and are identified as a need by the Strategic Plan for Inventories and Monitoring on National Wildlife Refuges: Adapting to Environmental Change (USFWS 2010a, b). Inventory and Monitoring is one element of the U.S. Fish and Wildlife Service's climate change strategic plan to address the potential changes and challenges associated with conserving fish, wildlife and their habitats (USFWS 2011). Water Resource Inventory and Assessments have been developed by a national team comprised of U.S. Fish and Wildlife Service water resource professionals, environmental contaminants Biologists, and other Service employees.

The WRIA summary narrative supplements existing and scheduled planning documents, by describing current hydrologic related information and providing an assessment of water resource needs and issues of concern. The WRIA will be a useful tool for Refuge management and future assessments, such as a hydro-geomorphic analysis (HGM) and Contaminants Assessment Process (CAP), and can be utilized as a planning tool for the Comprehensive Conservation Plan (CCP), Habitat Management Plan (HMP) and Inventory & Monitoring Plan (IMP). Much of the information within these plans relate to water resources and are reiterated in the WRIA summary narrative.

This Water Resource Inventory and Assessment (WRIA) Summary Report for Hackmatack refuge describes current hydrologic information, provides an assessment of water resource needs and issues of concern, and makes recommendations regarding Refuge water resources. As part of the WRIA effort for this Refuge, water resources staff in the Division of Natural Resources and Conservation Planning (DNRCP) received review comments and edits from Refuge Manager, Todd Boonstra.

This Summary Report synthesizes a compilation of water resource data contained in the national interactive online WRIA database (https://ecos.fws.gov/wria/). The information contained within this report and supporting documents will be entered into the national database for storage, online access, and consistency with future WRIAs. The database will facilitate the evaluation of water resources between regions and nationally. This report and the database are intended to be a reference for ongoing water resource management and strategy development. This is not meant to be an exhaustive nor a historical summary of water management activities at Hackmatack NWR.

The following two sections describe in detail the key findings and recommendations from this assessment. Relating to this, the online WRIA database list threats and needs for the refuge. Those threats and needs are compiled in a table in Appendix A.

1.1 Findings

1. Hackmatack NWR is an urban wildlife refuge. Water resources in urban areas often face a multitude of threats. As urban sprawl from suburban Chicago and the surrounding communities of Woodstock, Richmond, Wonder Lake, and others continues to expand, Nippersink Creek and its tributaries could experience increases in storm runoff, increased point source pollution, and negative impacts to water chemistry. Increased storm runoff could be caused by increased impervious surfaces, point source pollution could be caused by new wastewater treatment plants, and commercial or industrial developments, and changes in water quality could include greater specific conductance or nutrient pollution (Watershed Resource Consultants, Inc. 2008).
2. The acquisition of new parcels with existing, privately-owned agricultural drainage systems may pose challenges for the refuge. Careful consideration should be given to the constraints existing systems may pose to restoration activities, as well as the future maintenance needs of those landowners using the drainage system. Current or future changes to drainage infrastructure on private lands could cause excess surface water, insufficient surface or groundwater, or undesirable water quality for fish and wildlife on Refuge lands. Similarly, if the FWS restoration actions negatively impact drainage on neighboring lands, the refuge may be considered liable. Also, these drainage systems will require periodic maintenance which, if allowed, may involve access and construction activities on refuge lands.
3. Both historic rainfall and future climate projections suggest that the area around Hackmatack NWR is seeing more precipitation now than in the past and this trend will progress into the future as climate change continues. The area is showing both increases in the overall amount of annual rainfall as well as the frequency of large storm events. Spring and summer have shown the most dramatic increases thus far. In addition to increases in precipitation there are projections of risk from short-term droughts of 1-4 weeks as well (Wang et al. 2011).
4. Northwestern Illinois can expect an increase in the number of >95 degree days by 5-15 days by mid-century, and an increase of average temperature by about 3.8 to 4.4 degrees Fahrenheit. In addition to a lengthening growing season, studies point towards 11 to 16 less days with snow per year in the Chicago region by the end of the century.
5. Nippersink Creek has been listed by the State of Illinois as impaired for a number of number of chemical constituents that affect fish consumption, primary contact recreation, and aquatic life. Nonetheless, much of the Nippersink Creek watershed is considered among the highest quality stream resources in northeastern Illinois by the IEPA (USFWS 2012). The existing impairments, as well as increased agricultural or urbanization in the watershed, pose threats to aquatic life, such as the fish and wildlife on Refuge lands and easements. This threat has the potential to affect wetland water supply as well if connected to the river via floodwaters. Fish consumption and primary contact recreation have the potential to affect the Refuge in the future, if fishing and other river-based recreation become popular on Refuge properties.
6. In addition to the current water quality concerns in the Nippersink Creek basin, there are potential point source threats to water quality in the area as well. This assessment identified sixteen National Pollutant Discharge Elimination System (NPDES) permits in the area immediately surrounding the Hackmatack NWR conservation corridor. These

sites have the potential to degrade water quality and harm aquatic life if permitted discharges are accidentally exceeded at any point. Even if they are not exceeded, contaminants of emerging concern from point sources could pose a threat to Refuge species and habitats.

7. Along with surface water quality concerns, there is possible concern of groundwater quality as well. A groundwater site in the northeast portion the Hackmatack conservation corridor has shown increasing trends in specific conductance, indicating an increased in dissolved chemical constituents of the aquifer. This should especially be taken into consideration if groundwater is ever used as a water source for flooding wetlands or if a wetland receives seepage or discharge from groundwater.
8. Wonder Lake is an artificial impoundment in the downstream portion of the conservation corridor. It is surrounded by residential areas and is used for fishing and recreation. Any activities on refuge lands would need to consider and coordinate with this impoundment including wetland water releases, pumping water from Nippersink Creek, or any use of pesticides or chemicals that could end up in public waters.

1.2 Recommendations

1. Water quality is a high priority in the Nippersink Creek basin. A more in depth analysis of any existing or past water quality data should be undertaken to better understand the current status and trends of water quality in the area. This information will be used to design a water quality monitoring program for Refuge lands to better understand the potential risks of impaired water quality on aquatic wildlife and habitats. This monitoring should focus on dissolved nutrients and suspended sediment, as well as constituents listed as the source of 303(d) impairments including aldrin, nickel, mercury, PCBs, and fecal coliform. This monitoring should be completed prior to aquatic restoration efforts to determine the quality of source supply water.
2. Sources of impaired water quality in the Nippersink Creek watershed should be addressed using agricultural BMPs, riparian buffers, and conservation easements. This would reduce the amount of nutrients, sediments, and other agricultural runoff reaching Nippersink Creek. These efforts would complement restoration activities associated with refuge acquisition and easements, and combined may play an important role in improving and protecting the water quality of Nippersink Creek.
3. Any future acquisition of future lands for Hackmatack NWR and subsequent restorations should involve a review of relevant hydrologic factors. This could include the amount of on-site flooding and drainage, water quality concerns, trends in water quantity, and any potential water rights or drainage law issues.
4. More information should be gathered and synthesized on local NPDES permits. An assessment should incorporate what chemical constituents are being discharged and how often. NPDES monitoring data should be periodically reviewed online to track any potential exceedances. The frequency and magnitude of exceedances will help assess potential impacts on aquatic life.
5. Efforts should be made to coordinate restoration and water quality improvements across landscape with other stakeholders in the Nippersink Creek Watershed. A broad, multi-stakeholder partnership would serve to highlight the benefits and ecosystem services provided by the Refuge's land acquisition and restoration actions, such as improved

water quality. Working in close accord, this partnership could help improve water quality beyond the Refuge's borders, benefiting other local water resources such as Wonder Lake.

6. Restoration efforts should take into account the shifting trends in hydroclimate and flood peaks in the area. Wetland, stream, and other aquatic restorations should be designed with sustainable infrastructure that accounts for the hydrologic extremes Nippersink Creek may face in the coming decades.

Chapter 2: Introduction

The idea of establishing Hackmatack NWR was born from a group called the 'Friends of Hackmatack' who were very interested in designating a refuge to complement existing conservation lands in Northeastern Illinois (McHenry County) and Southeastern Wisconsin (Walworth County). The proposal to acquire core refuge units and connect natural corridors was selected from various alternatives for implementation in 2011 (USFWS 2012). The vision is for the FWS to eventually implement conservation on the 11,000-12,000 acres within the donut-shaped conservation corridor as part of Hackmatack NWR. This effort will be done through promoting of private landowner conservation efforts and acquisition of property and conservation easements. Private property exists within this corridor; however, land will only be acquired from willing landowners through purchase, donation, or exchange (USFWS 2012). On November 6, 2013, Hackmatack NWR was officially established through the transfer of a 12-acre easement to the FWS. In the summer of 2018, two more parcels were acquired. These include an 87-acre (Turner tract) located in the northeast portion of the conservation corridor and a 27-acre (Perricone tract) located in the southwestern portion of the conservation corridor.

As described in the Hackmatack NWR Environmental Assessment (USFWS 2012) the purpose of this refuge is to contribute to the mission of the National Wildlife Refuge System by:

- *"Protecting and enhancing habitats for federal trust species and species of management concern, with special emphasis on migratory birds and species listed under the federal Endangered Species Act of 1973.*
- *Creating opportunities for hunting, fishing, wildlife observation and photography, and environmental education and interpretation, while promoting activities that complement the purposes of the refuge and other protected lands in the region.*
- *Promoting science, education, and research through partnerships to inform land management decisions and encourage continued responsible stewardship of the natural resources of the region."*

This refuge contributes to a long-standing vision held by many conservation entities across the Greater Chicago metropolitan area (USFWS 2012). These partners from local county, state and federal agencies have been working together to identify prime lands for conservation, open space, and greenways aimed at providing a way to link urban and suburban residents with nature. The primary purpose for establishing an urban refuge, like Hackmatack, is to foster environmental awareness and outreach programs, and to develop an informed and involved community that will support fish and wildlife conservation (https://www.fws.gov/refuge/hackmatack/). One key topic that Hackmatack is poised to foster awareness on is water quality in the Nippersink Creek watershed.

The conservation corridor for Hackmatack is currently comprised of a patchwork of wetlands, grasslands and streams. The area includes sculpted remnants of moraines, kames, kettle marshes, and bogs from past glacial activity. During the developing years of this new refuge, priorities for management will include habitat restoration, building community cooperation, and inventory/monitoring of migratory birds and unique plant communities. Hackmatack NWR will continue to restore habitat by purchasing lands from willing sellers and by helping landowners restore their own land.

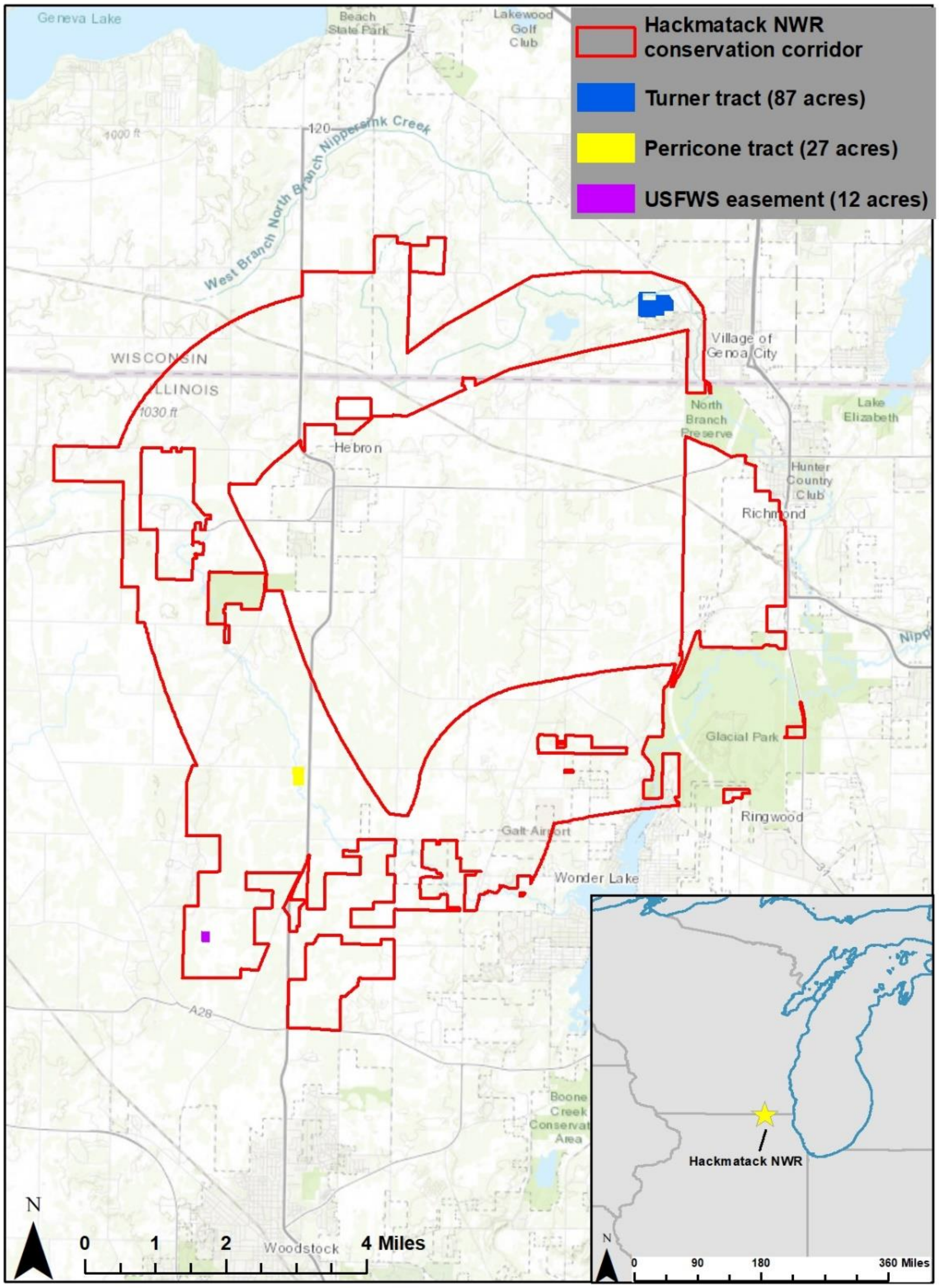


Figure 2.1: Hackmatack NWR conservation corridor and acquired tract boundaries

Chapter 3: Natural Setting

The natural setting section describes the abiotic resources associated with the Refuge, including relevant watershed boundaries, topography, and climate. These underlying, non-living components of an ecosystem provide the context on which water resources are constructed and managed. Many of these elements are also described in the Hackmatack NWR Environmental Assessment, Land Protection Plan, and Conceptual Management Plan (USFWS 2012).

3.1 Region of Hydrologic Influence (RHI)

Hydrologic information can be described in the context of Hackmatack NWR's designated Region of Hydrologic Influence (RHI), which is the relevant region for the collection of water quality and quantity information. Hackmatack's conservation corridor lies within three HUC (Hydrologic Unit Code) 10 boundaries (Figure 3.1). Those are (north to south): North Branch Nippersink Creek, Nippersink Creek and Rush Creek-Kishwaukee River. Nippersink Creek and its tributaries flow east into the Fox River, while a small portion of the conservation corridor drains to the Kishwaukee River. Hackmatack NWR lies just to the east of the continental divide separating the Great Lakes from the Illinois and Mississippi River watersheds (USFWS 2012). HUCs designate watersheds of various sizes and often represent the initial aggregate level of water quality and quantity information available from a variety of agencies. HUC boundary datasets can be obtained from https://gdg.sc.egov.usda.gov/GDGOrder.aspx?order=iMapOrder.

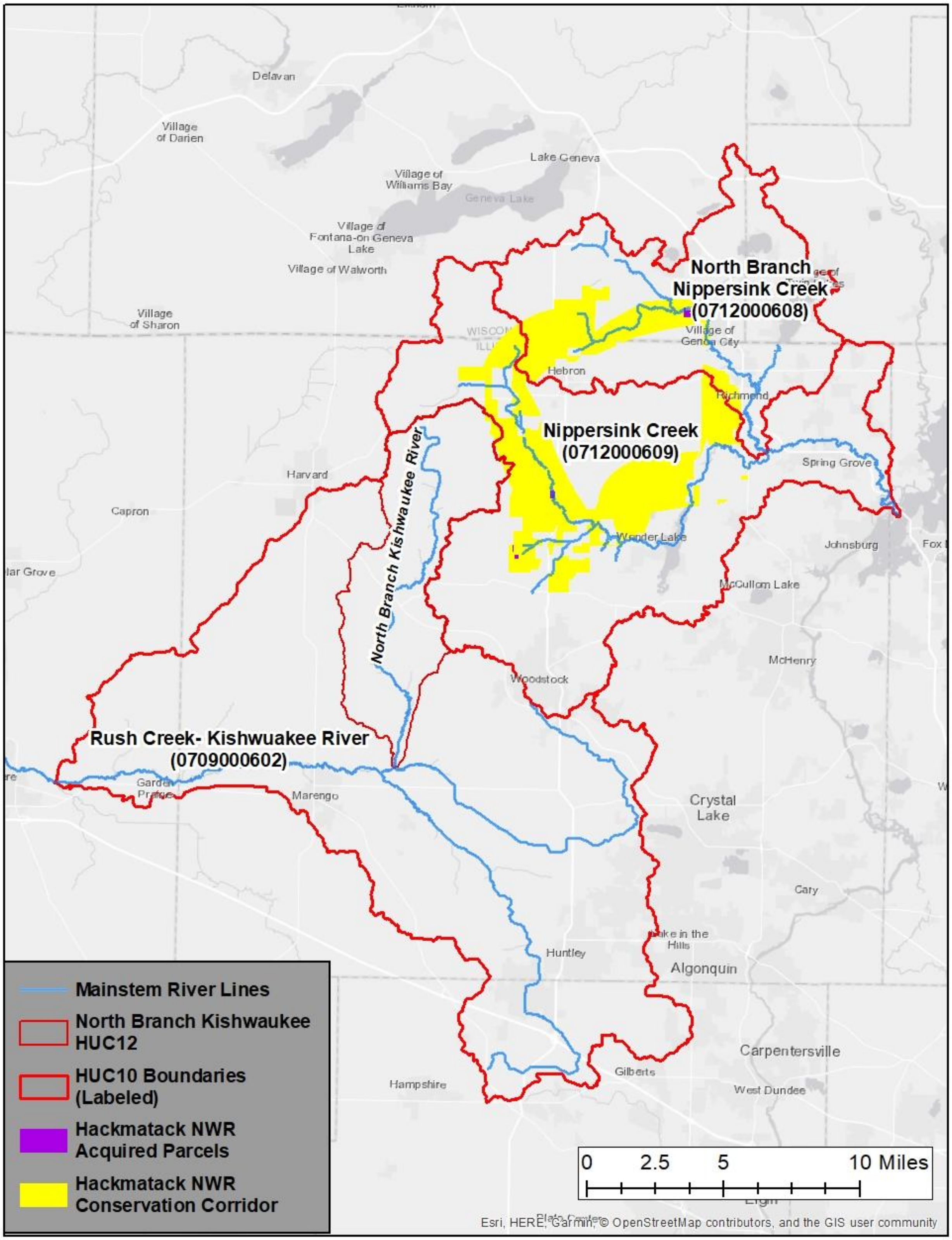


Figure 3.1: HUC 10s relevant to Hackmatack NWR conservation corridor

3.2 Topography

High resolution (1-meter) bare-earth LiDAR data (NAVD88) is currently available for Hackmatack NWR. It was obtained from McHenry County, Illinois (2008), Kenosha County, Wisconsin (2010), and Walworth County, Wisconsin (2015). The raw data was processed by Vince Capeder (FWS 2018). Topographic maps are shown below (Figure 3.2). As the local topography shows, most of the Hackmatack NWR conservation corridor follows the valleys comprising the Nippersink Creek and North Branch Nippersink Creek.

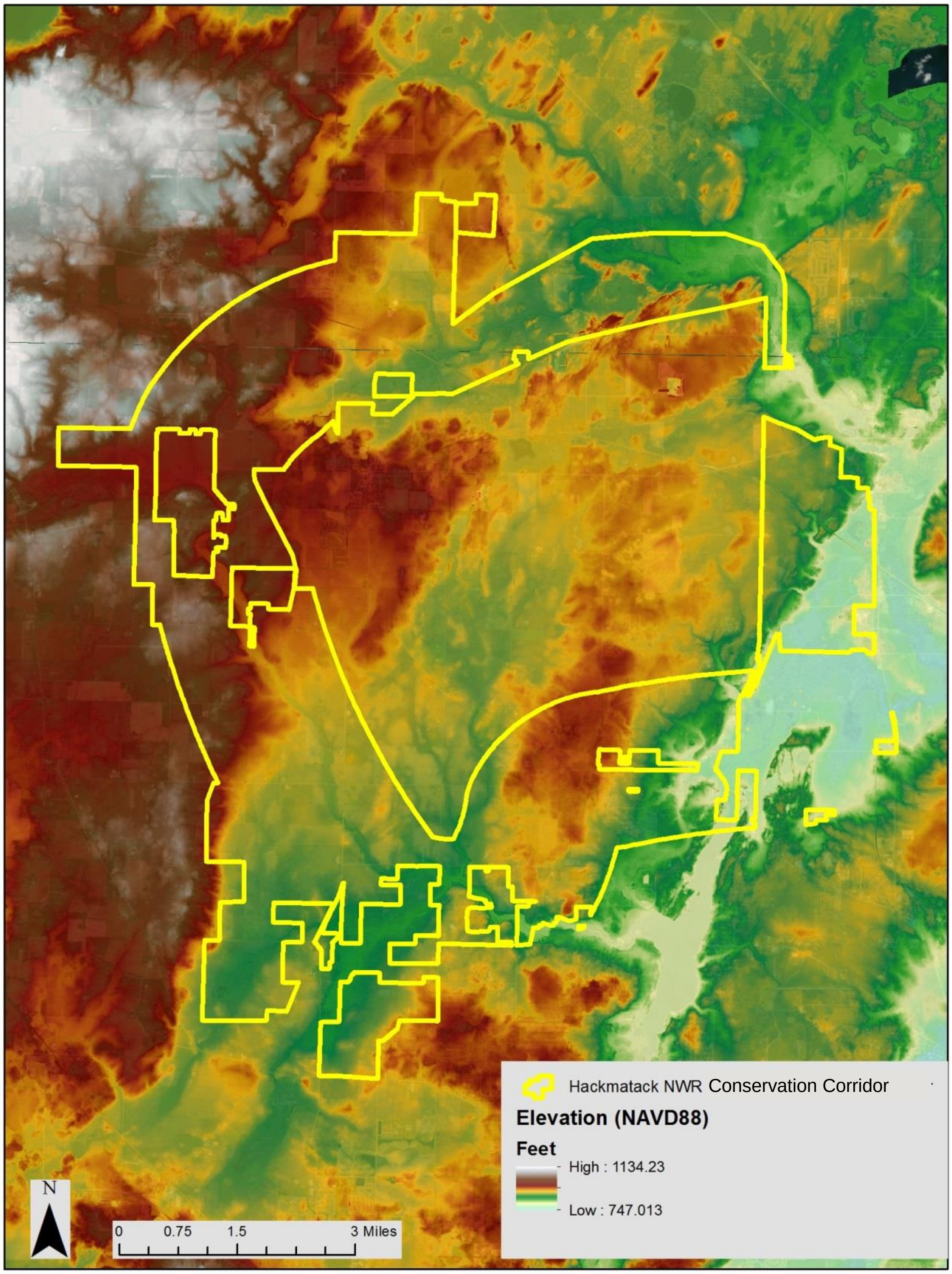


Figure 3.2: Topographic Lidar map of Hackmatack NWR.

3.3 Long Term Climate Trends

The WRIA provides a preliminary broad-based analysis of trends and patterns in precipitation and temperature. Climate is defined here as the typical precipitation and temperature conditions for a given location over years or decades. These types of trends and patterns affect groundwater levels, river runoff, and flooding regularity and extent. This section evaluates Hackmatack NWR's current and historical climate patterns by:

- discussing the current climate and changes already experienced in the region
- briefly summarizing projections for the future from selected models
- analyzing U.S. Historical Climatology Network (USHCN) datasets

Historical climate conditions

The climate of the region surrounding Hackmatack NWR is unique in that it exhibits both continental and lake-moderated characteristics. The Hackmatack NWR Environmental Assessment (EA) describes historic average temperatures and precipitation as follows (USFWS 2012):

> "The climate of the Study Area ranges from continental to humid continental with wide variations closer to Lake Michigan. The winters are cold and snowy while the summers are warm and wet to hot and humid. About two-thirds of the annual precipitation falls during the growing season (freeze-free period). The average annual temperature is about 50ºF, with an average temperature of 30ºF in the winter and 70ºF in the summer (Climatography of the United States, 2011)."

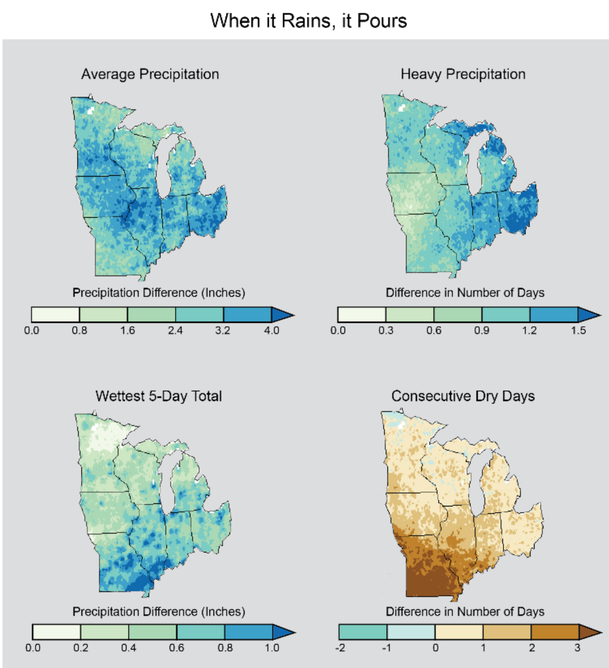
The EA goes on to describe the average precipitation of the area as approximately 30 - 35 inches per year, the annual average number of days with snowfall cover as being 85, and 38 - 52 inches of snowfall per year is common (USFWS 2012).

Projected Climate Changes

The nation as a whole has experienced a 1.3 -1.9 degree Fahrenheit increase in average temperatures since 1895, and can expect a 2-4 degree increase over the next century (Melilo et al. 2014), although this rate of change is not uniform over all regions of the country or over time (Winkler et al. 2012, Melilo et al. 2014). In addition to higher average temperatures, heat waves may become more common with days per year >90 degrees Fahrenheit projected to increase 2-3 times by the end of the century (Hayhoe et al. 2012). Northwestern Illinois can expect an increase in the number of >95 degree days by 5-15 days by mid-century, and an increase of average temperature of approximately 3.8 - 4.4 degrees Fahrenheit (Pryor et al. 2014, Baylis et al. 2015) (Figure 3.3). Apparent temperatures (i.e. heat index) are expected to rise as well in the Chicago and northern Illinois area due to increases in humidity and accentuating heat stress conditions (Vavrus and Van Dorn 2010).

Currently, the Midwest is experiencing an increase in the average frost free season by 9 days compared to historic times (Melilo et al. 2014). This is projected to increase to 14 days by mid-century and 28 days by the end of the current century (Pryor et al. 2013). In addition to a lengthening growing season, studies point towards 11 to 16 less snow days per year in the Chicago region by the end of the century (PCCRC 2008, Hayhoe et al. 2010).

Several reports indicate the Midwest is also experiencing much more frequent and intense rainfall events in the region compared to a century ago (Kunkel et al. 2003, Winkler et al. 2012, Kunkel et al. 2013). There are also estimates that intense precipitation events will increase, with both the 24-hour and 7 day rainfall events doubling by the end of the century (Wuebbles and Hayhoe 2004) The Midwest is experiencing an increase in runoff and suspended sediment loads (Johnson et al. 2015) and this trend is



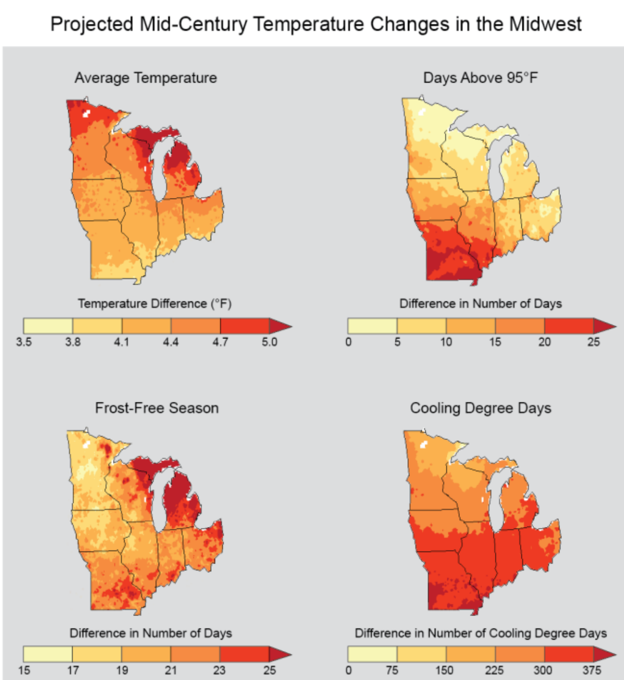


Figure 3.3: Projected changes in climate across the Midwest by mid-century (NOAA NCDC / CICS-NC, 2014)

expected to continue. In addition to more flooding, increased risk of short term droughts (1-4 weeks) will likely become more common and severe in Illinois (Wang et al. 2011).

USHCN Dataset

Data was obtained from a site from the U.S. Historical Climatology Network ([USHCN]; http://cdiac.ornl.gov/epubs/ndp/ushcn/ushcn.html; Menne et al. 2012). The USHCN is a network of sites listed by the National Weather Service, which maintains standards in quality and continuity of data collection.

The closest USHCN station with adequate climate data is *Beloit, WI, US No. 470696*. It is located roughly 25 miles west of the Hackmatack NWR acquisition boundary. It has an elevation of 780 feet NAVD88 with much of the Refuge having elevations in the range of 780 to 1,000 feet NAVD88. The Beloit location is further from Lake Michigan compared to Hackmatack NWR, and as such might experience a slightly less moderated climate. This factor should be considered when analyzing the data. Years with more than one missing month of data were dropped from the analysis to avoid erroneous annual statistics. There are other various climate stations near the refuge but were not included due to a short period of record, a partially incomplete record, or were too great a distance from the refuge boundary.

- The Beloit, WI USHCN weather station (1917-2017) showed a mean annual water year precipitation of 32.24 inches, with the wettest years on record occurring in 1993, 1986, 1972, 1938, 1999, and 1960, while particularly dry years occurred in 1917, 1956, 1958, 1946, 1971, and 1948 (Figure 3.8). The highest total monthly rainfall typically occurs in June (5.14 inches) and the least occurs in February (1.41 inches) (Figure 3.4). Total averages for cool-season (October-March) precipitation is 10.86 inches.
- The amount of 2-inch or larger rain events since the beginning of the data record showed an increasing trend, though this trend was not statistically significant (Table 3.1, Figure 3.7. However, there was a statistically significant increase in the amount of spring and summer precipitation over the period of record ($p = 0.010$, $p = 0.002$) (Table 3.1, Figure 3.10. Total annual precipitation also showed a statistically significant positive trend for this site ($p = 0.002$) (Table 3.1, Figure 3.8).
- The trend for increased extreme precipitation is further explored in Table 3.2. Rainfalls of 0.01 inches or greater in a day have increased in the past 25 years (1993-2017) compared to the historic record (1900-1992). The strongest increases seem to be of 1 to 2 inches of rain in a day, although, rainfalls of 3 inches have shown a decrease. Rainfalls of 4 inches or more in a day occurred 3 times in the past 25 years as opposed to only twice in the previous 93 years (a 416 percent increase).
- Average monthly temperatures are typically highest in July (72.4°F) and coolest in January (20.7°F) (Figure 3.5). Temperature parameters showing a statistically significant trend include the annual average maximum temperature and summer average maximum temperature ($p = 0.010$, $p < 0.001$), which both showed decreasing trends (Table 3.1, Figure 3.9). Future climate predictions show these parameters increasing significantly throughout the current century (Melilo et al. 2014).
- Average growing length season (> 32F) showed a slight statistically significant increasing trend ($p = 0.065$) (Table 3.1, Figure 3.6). The mean for the period of record (1900-2017 was 170.6 days, but the linear trend shows an increase from approximately 165 to 175 days within this time period.

Kendall's Tau Non-Parametric Monotonic Trend Test

Dependent Variable	p-value	slope	median
Annual Average Precipitation	0.002	(+)	33.66
Average Summer Precipitation	0.002	(+)	11.25
Average Spring Precipitation	0.010	(+)	8.26
Average Annual Maximum Temperature	0.01	(-)	58.39
Average Summer Maximum Temperature	< 0.001	(-)	82.67
Average Growing Season Length	0.065	(+)	170.0
Annual # of Days With Precipitation > 2"	0.141	(+)	1.0

Table 3.1: Statistically significant climate trends for 1927-2017, Station No. 470696, Beloit, WI

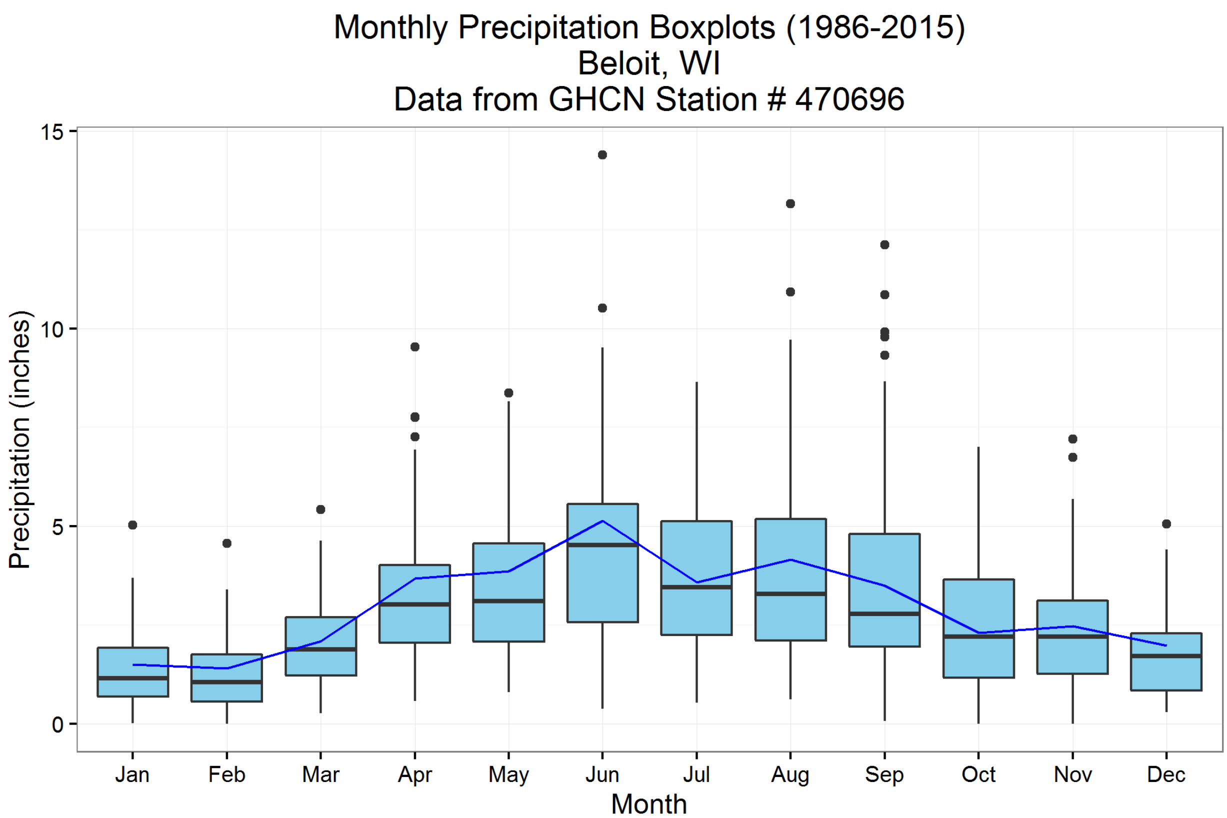


Figure 3.4: Average total monthly precipitation (1986-2015), Station No. 470696, Beloit, WI

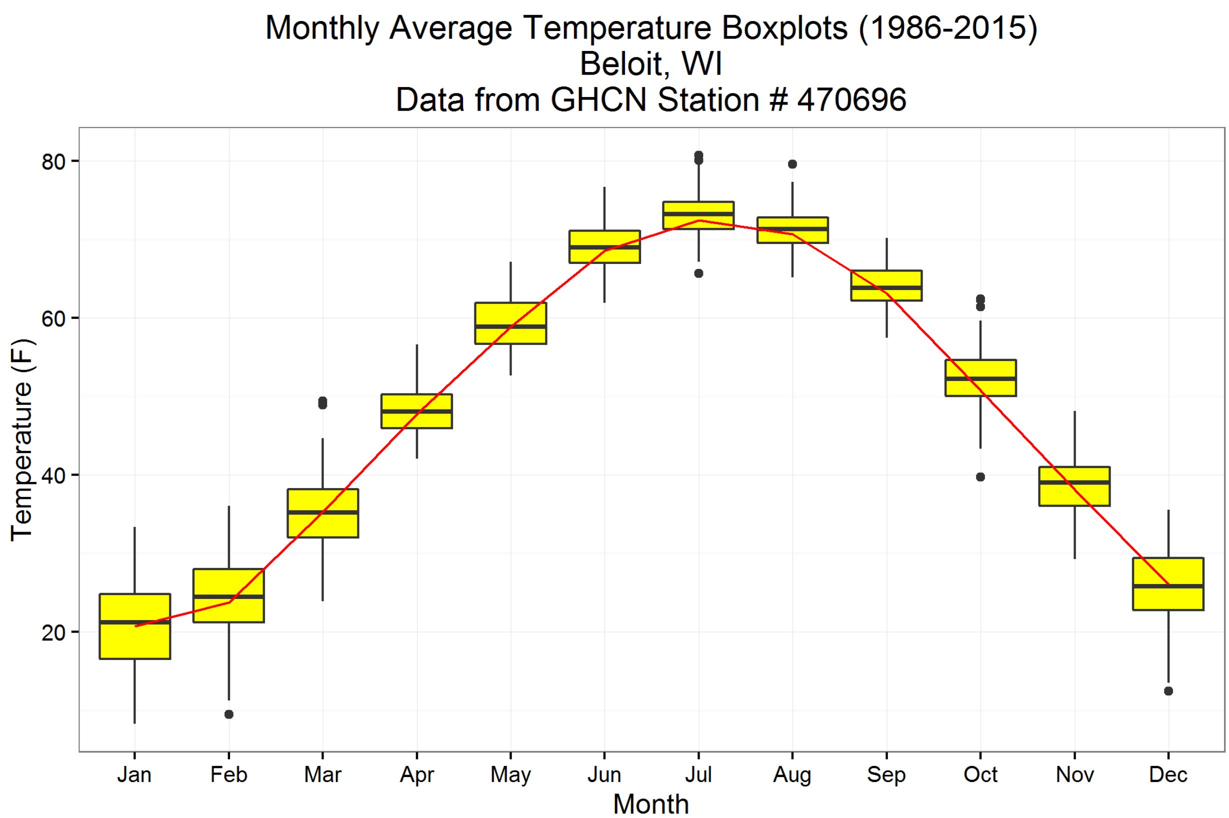


Figure 3.5: Average monthly temperatures (1986-2015), Station No. 1470696, Beloit, WI

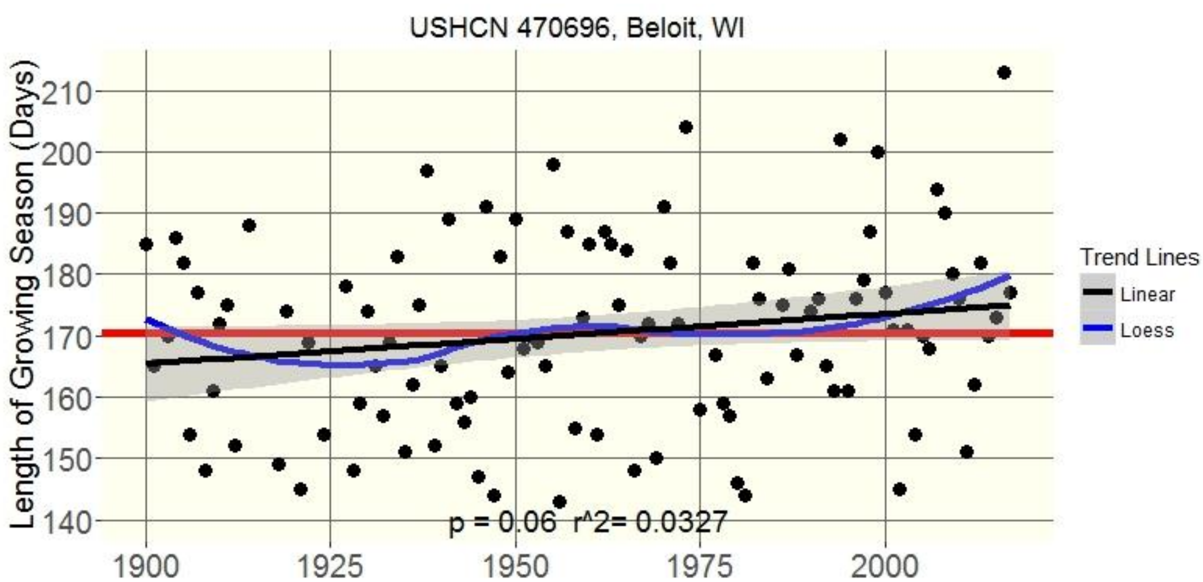


Figure 3.6: Length of growing season (last freeze, < 32F, in Spring to first freeze in Fall) for Beloit, WI 1900-2017. Red line is average growing season length (170.6 days), black line is a linear regression, and blue line is a LOESS regression.

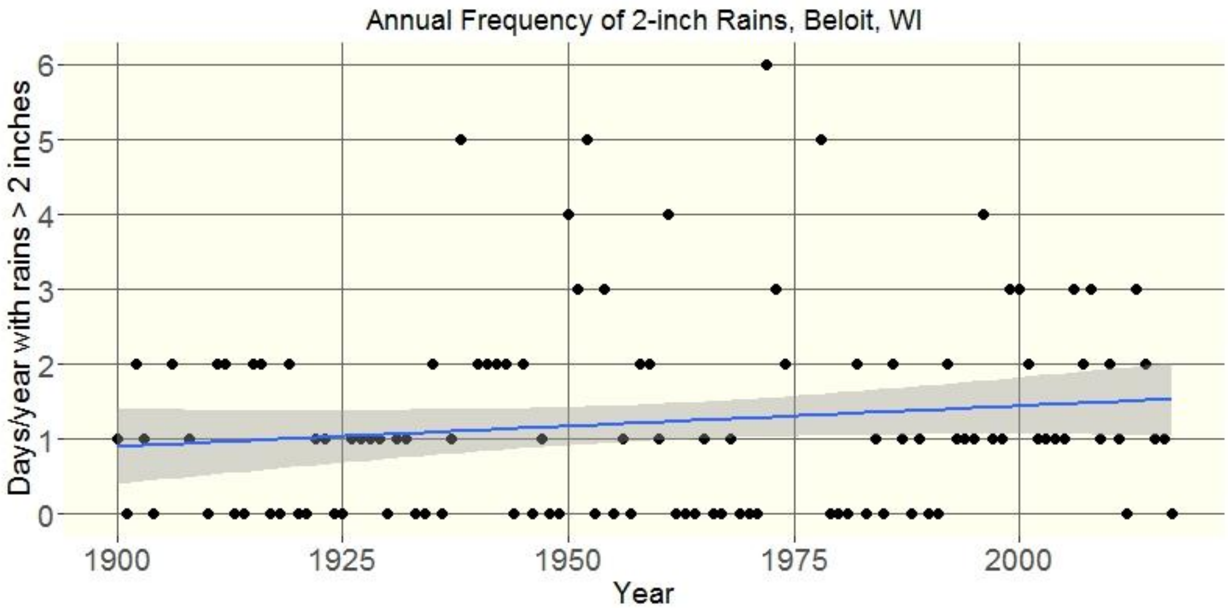


Figure 3.7: Number of days per year with 2-inches or greater of precipitation (1900-2017) (median = 1.0) for Beloit, WI. Blue line is a linear regression.

Inches of rain in a day equaled or exceeded	Avg. Number of days/year (1900-1992)	Avg. Number of days/year (1993-2017)	Percent Change
4.00	0.02	0.12	**+ 416%**
3.00	0.27	0.24	**- 10%**
2.00	1.12	1.60	**+ 43%**
1.00	7.05	8.36	**+ 19%**
0.50	20.67	22.48	**+ 8.7%**
0.25	37.51	39.96	**+ 6.5%**
0.10	58.45	61.16	**+ 4.6%**
0.05	71.79	74.08	**+ 3.2%**
0.01	89.59	97.48	**+ 8.8%**

Table 3.2: Cumulative frequency of daily rains for Beloit, WI. Comparison of past conditions (1900-1992) to contemporary conditions (1993-2017).

Recurrence Interval	1-Hour Rain (Inches)	24-Hour Rain (Inches)
1-Year	1.18	2.49
2-Year	1.39	2.87
5-Year	1.74	3.56
10-Year	2.03	4.18
50-Year	2.77	5.90
100-Year	3.11	6.74
500-Year	3.91	8.92

Table 3.3 Precipitation frequency estimates for Beloit, WI. Data obtained from NOAA Precipitation Frequency Data Server (PFDS).

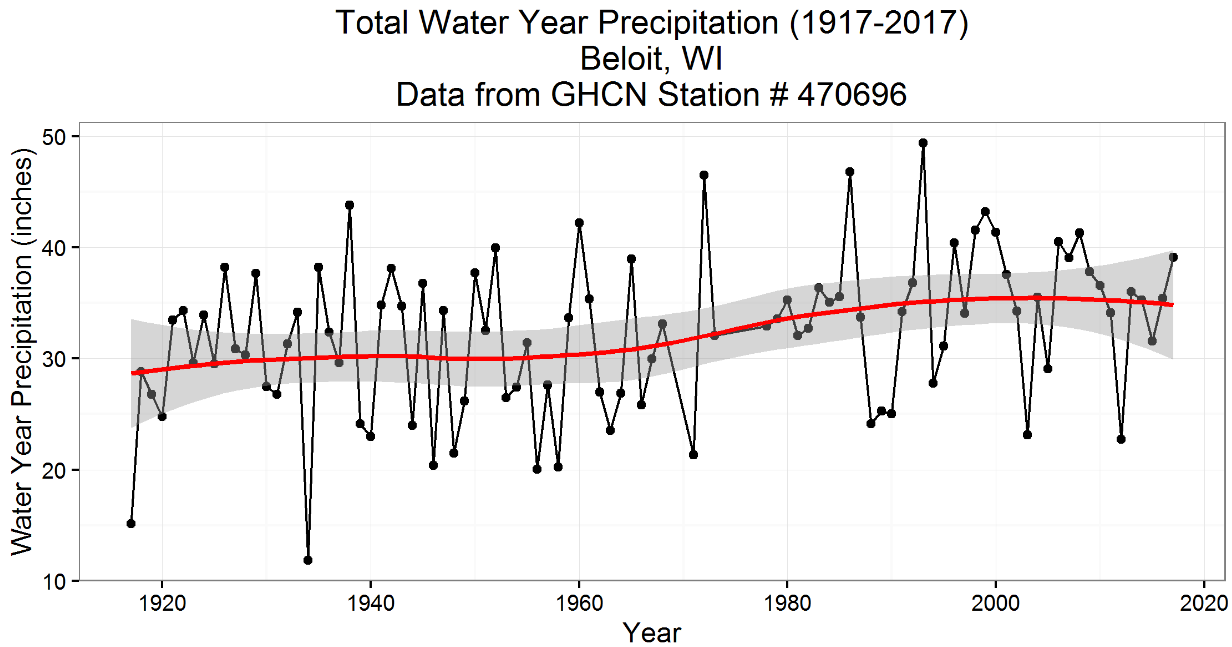


Figure 3.8: Water year annual precipitation (inches) (1917-2017), Station No. 470696, Beloit, WI

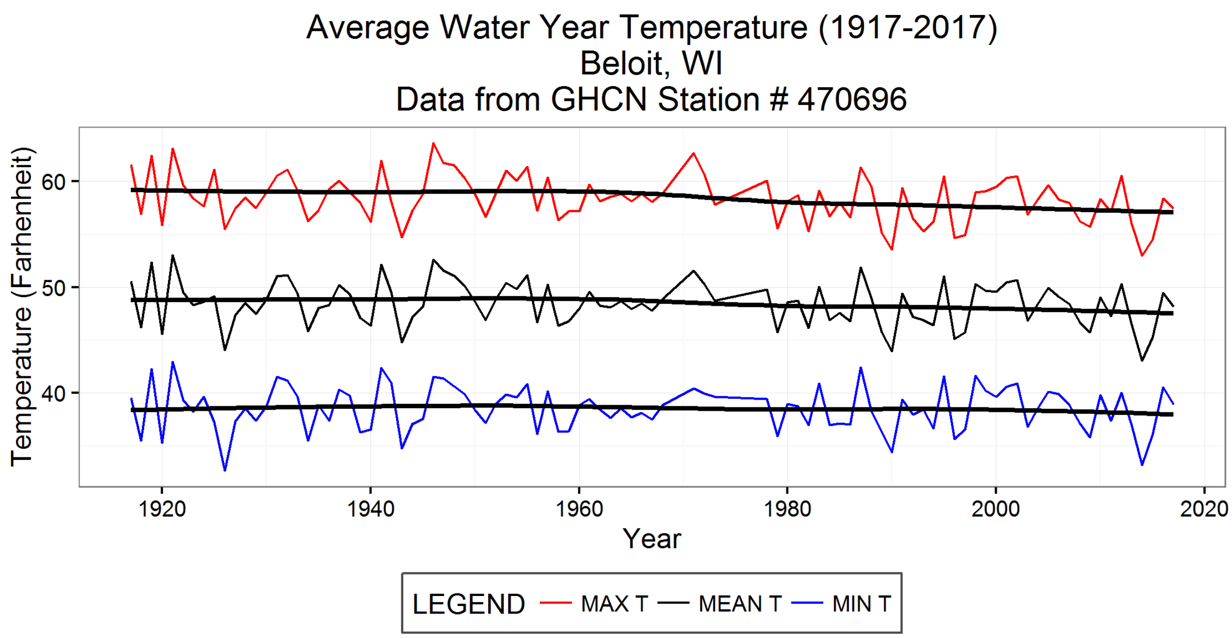


Figure 3.9: Water year average maximum, minimum, and mean temperatures (Fahrenheit) (1917-2017), Station No. 470696, Beloit, WI

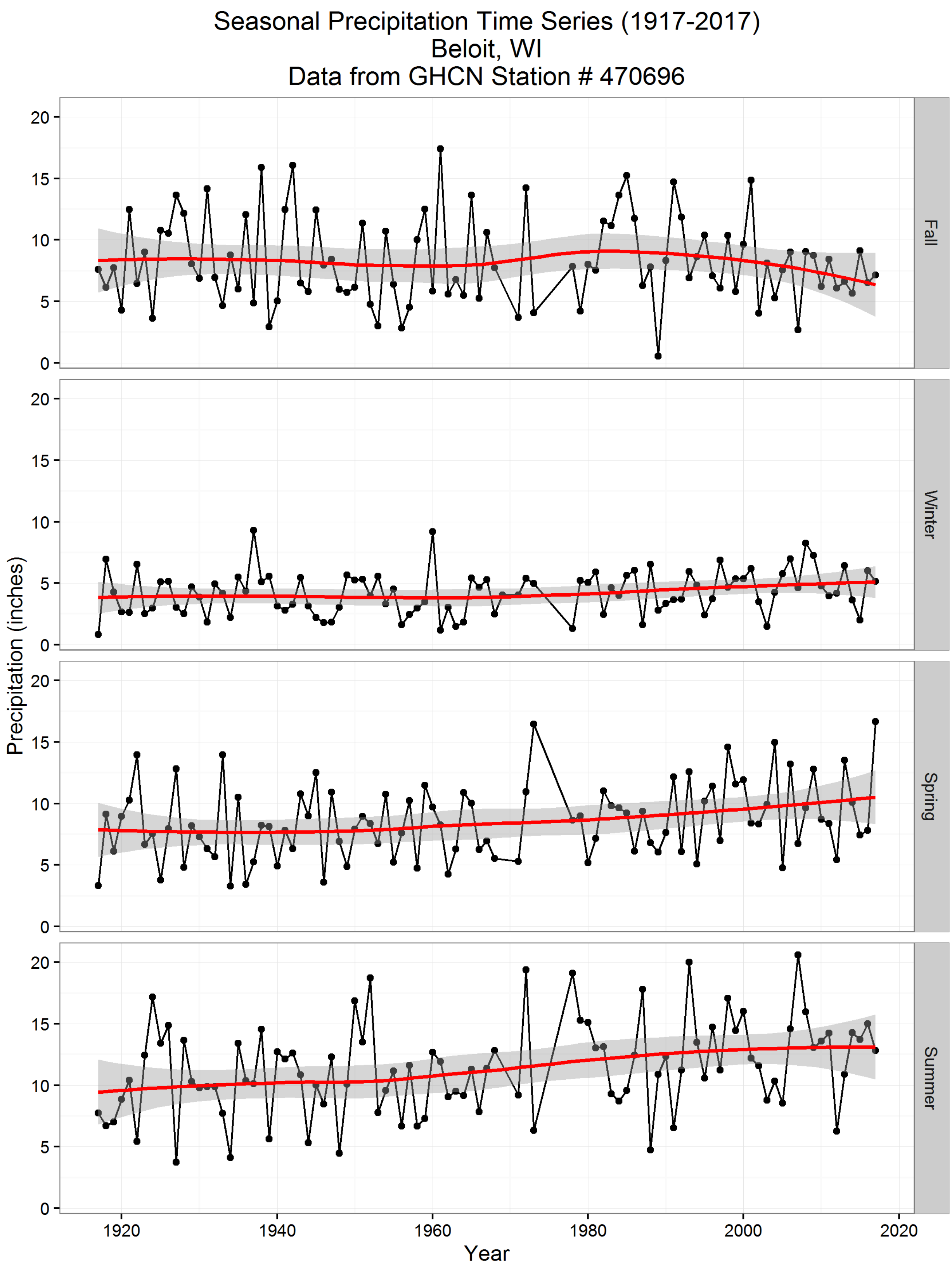


Figure 3.10: Seasonal precipitation trends (inches) (1917-2017), Station No. 470696, Beloit, WI

Chapter 4: Water Resource Features

4.1 Management Units

In November of 2013, Hackmatack NWR was officially established through the transfer of a 12-acre easement to the Service (Figure 4.1). This parcel is located in the southwest area of the conservation corridor in McHenry County, Illinois and is surrounded by IDNR land. It is a reed canary grass marsh habitat. There is no public access or management of this 12-acre parcel.

The vision for Hackmatack NWR is to protect 11,000 to 12,000 acres of land in the identified conservation corridor. This will be accomplished by collaboration with other conservation agencies and willingness of private landowners (Refuge staff, personal communication, March 2018). Hackmatack NWR has an extremely devoted friends group that will be influential in this process.

In spring of 2018, two more parcels were acquired at Hackmatack NWR within the conservation corridor. These are the 87-acre Ducks Unlimited (Turner) tract (Figure 4.2) and the 27-acre Openlands (Perricone) tract (Figure 4.1). Both of these parcels are open to hunting and fishing. Some restoration work has been done at these two parcels (Refuge staff, personal communication, March 2018).

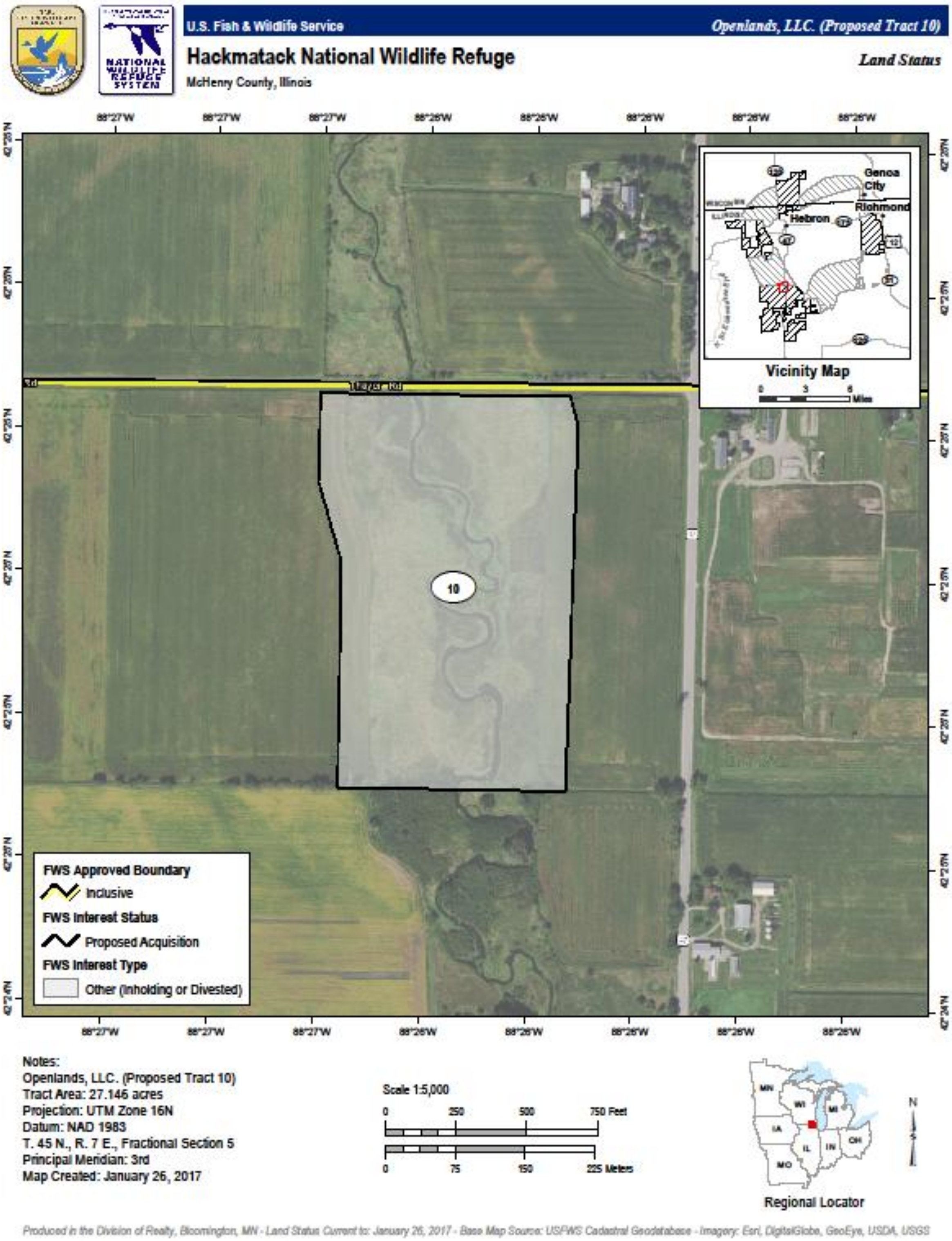


Figure 4.1: Perricone tract (Region 3 Realty office of USFWS)

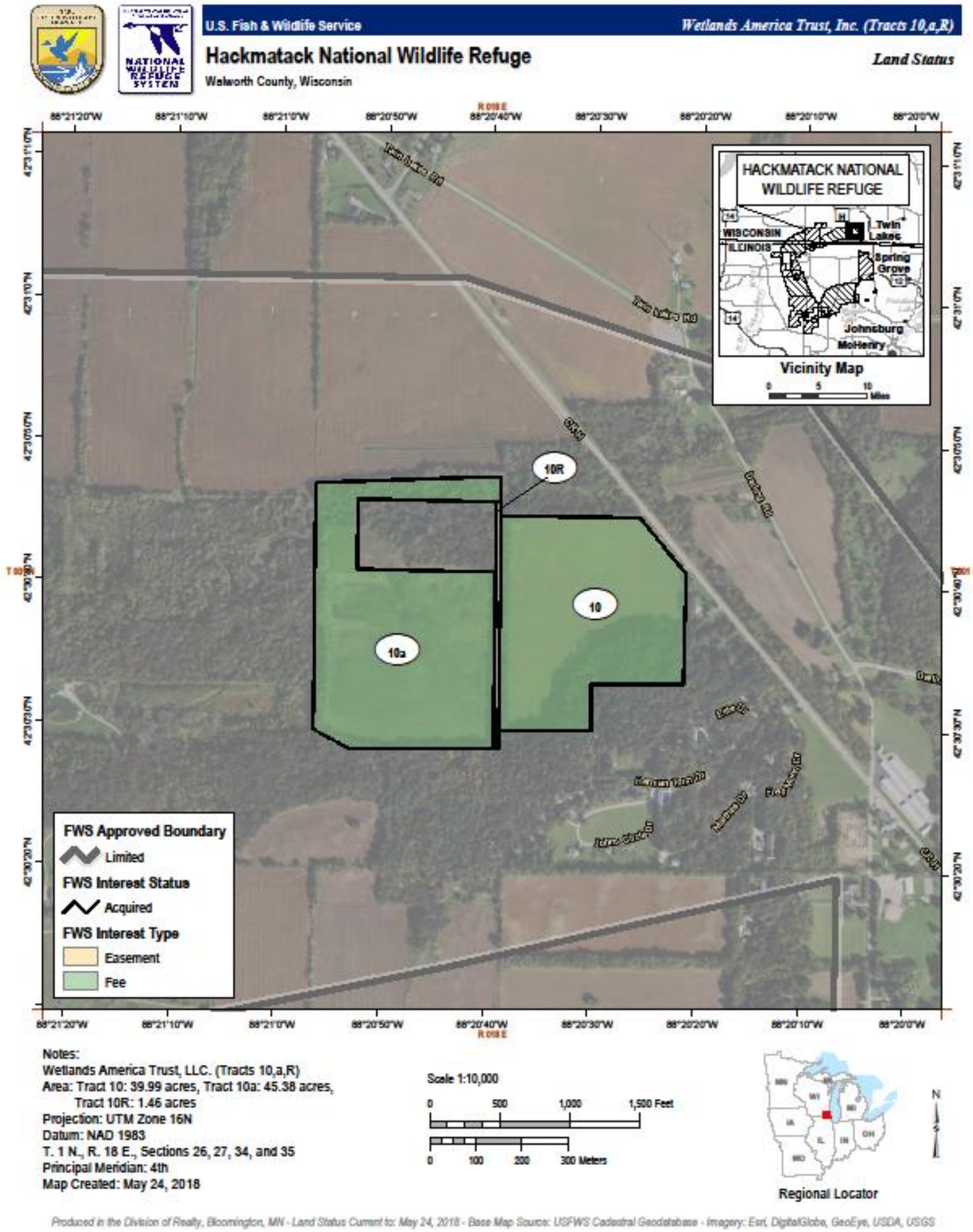


Figure 4.2: Turner tract (Region 3 Realty office of USFWS)

4.2 National Wetlands Inventory

The National Wetland Inventory (NWI) is an extensive, ongoing survey by the USFWS, of aquatic habitats across the United States. The NWI is based on interpretation of aerial photographs, not ground surveys, and its criteria differ somewhat from those used in jurisdictional wetland delineations for permitting by the United States Army Corps of Engineers under Section 404 of the Clean Water Act. Classifications may also be somewhat outdated. Wetlands data for Hackmatack NWR can be accessed using the NWI Wetlands Mapper found at this website: https://www.fws.gov/wetlands/Data/Mapper.html.

4.3 National Hydrography Dataset

The National Hydrography Dataset (NHD) is a vector geospatial dataset including information about the nation's lakes, ponds, rivers, streams, and other water features that are part of the USGS's National Map (data is obtained from here: https://viewer.nationalmap.gov/basic/). Within the unit boundaries, the flowpaths identified by the NHD can be broken down based on type. Figure 4.4 displays the NHD flowlines for Hackmatack NWR's conservation corridor and surrounding area.

The NHD provides an approximate representation of general water flow and does not necessarily reflect actual conditions. Further, the NHD's inventory of "named features" is not necessarily all-inclusive, and some of the flowlines may be mis-categorized.

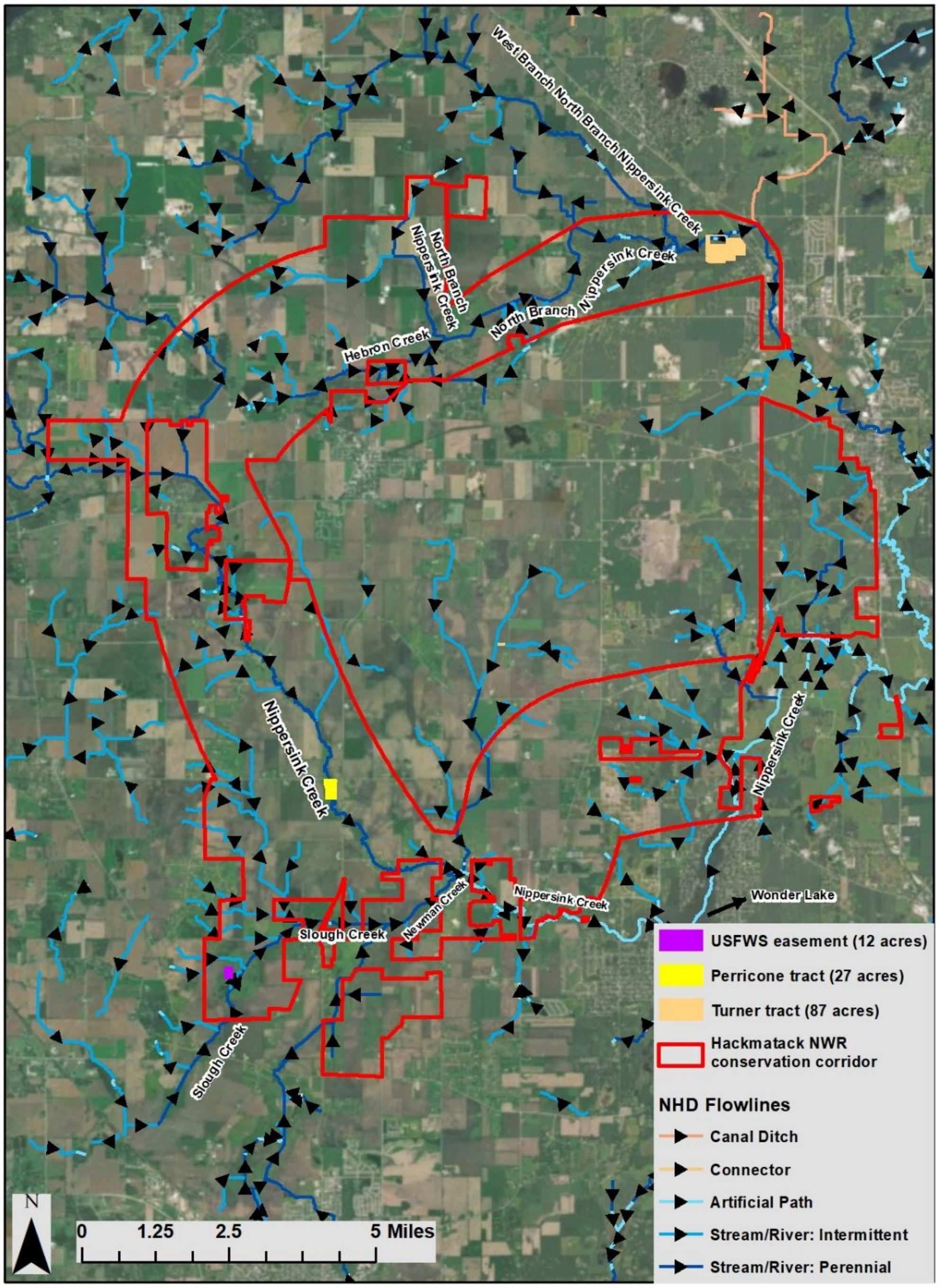


Figure 4.3: NHD flowlines for conservation corridor and surrounding area

Chapter 5: Water Resource Monitoring

The WRIA identified historical and ongoing water resource related monitoring on or near Hackmatack NWR. The surface and groundwater quantity stations were chosen because they lie within or in close proximity to the conservation corridor boundary. Relevant sites were evaluated for applicability based on location, period of record, extensiveness of data, sampling parameters, trends, and dates of monitoring. Water resource datasets collected on HNWR can be categorized as water quantity or water quality monitoring of surface or groundwater.

Water quantity monitoring typically involves measurements of water level and/or volume in a surficial water body or subsurface aquifer. Water quality can include laboratory chemical analysis, deployed sensors or biotic sampling such as fish assemblages or invertebrate sampling. Biotic sampling is often used as an indicator of biological integrity, which is a measure of stream purpose attainment by state natural resource management organizations. Potential water quality threats may be identified by comparing monitoring data with recommended standards.

5.1 Water Monitoring Stations and Sampling Sites

Several resources offer water quality and quantity datasets relevant to the Hackmatack NWR and were utilized in the creation of Hackmatack NWR's water monitoring site inventory:

- Data for historical sampling locations can be retrieved through the EPA STORET (STOrage and RETrieval; http://www.epa.gov/storet) database. This data warehouse is a repository for water quality, biological, and physical data used by state environmental agencies, EPA and other federal agencies, universities, and private citizens.
- Water quantity and quality data for active and inactive monitoring sites can also be accessed from the USGS National Water Information System (NWIS) database (http://www.waterqualitydata.us).

The WRIA identified 3 monitoring sites that are considered applicable to Hackmatack NWR's water resources; 2 surface water monitoring sites and 1 groundwater monitoring station (Table 5.1).

Site Name	ID and Link	Location (decimal degrees)	Elevation	Notes	Record maintained by:
North Branch Nippersink Creek near Genoa City, WI	USGS-05548150	Latitude 42.5042 Longitude 88.3836 NAD27	--------	Peak streamflow (1962-2015)	USGS Wisconsin Water Science Center
Nippersink Creek above Wonder Lake, IL	USGS-05548105	Latitude 42.3853 Longitude 88.3694 NAD27	797.65 feet above NAVD88	Discharge (1994-present), gage height (1994-present), peak streamflow (1995-present), precipitation (2009-present), some water quality samples (1994-2014)	USGS Illinois Water Science Center
46N8E-08.2e1 (well site)	USGS-422848088191001	Latitude 42.48 Longitude 88.31944 NAD83	Land surface: 844.15 feet above NAVD88	Depth to water level (2009-present), specific conductance (2001-2017), temperature (2015-present)	USGS Illinois Water Science Center

Table 5.1: Water monitoring stations relevant to Hackmatack NWR

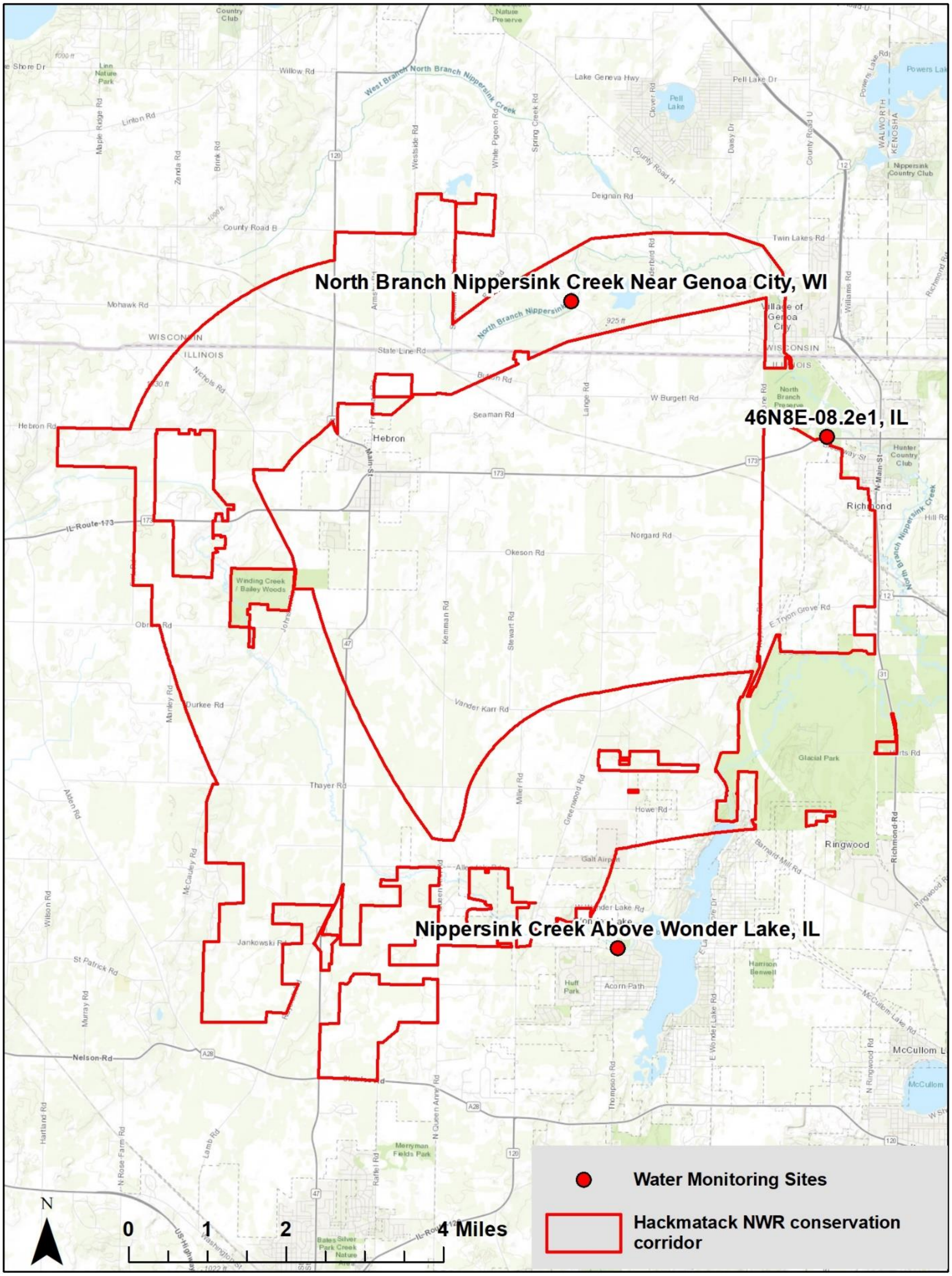


Figure 5.1: Relevant water monitoring sites near Hackmatack NWR.

5.2 Surface Water Quantity

Two surface water quantity monitoring sites were analyzed for this report to assess general trends and averages for the area.

1. USGS-05548105, Nippersink Creek above Wonder Lake, IL. This site is located on the main stem of Nippersink Creek and is located near the southeast corner of the approved conservation corridor, downstream of the Perricone tract and USFWS easement. This particular gaging site is located slightly outside of the conservation corridor, has a drainage area of 84.5 square miles and may be impacted by the management of Wonder Lake, an impoundment on the Nippersink built in 1929, but serves as an example of the general trends and behavior of Nippersink Creek. This gage has a period of record from 1995-present but has numerous years of missing data including 1998 and 2002-2009. The lack of a complete, long-term data set should be kept in mind when interpreting these data. Average annual flows for Nippersink creek range from as low as 43 cfs (2012) to 120 cfs (2018). There appears to be a slight positive trend in annual average flows with higher annual averages occurring in recent years. This matches streamflow trends for the region but it is hard to say if it is a definitive trend given the short period of record and missing data. When averaged by month, the average flows for Nippersink Creek appear to be highest in June (138 cfs), with April through June averaging over 100 cfs (Figure 5.3). The lowest flows occurringin September (29 cfs).

2. USGS-05548150, North Branch Nippersink Creek Near Genoa City, WI. This gage is located in the northernmost part of the Hackmatack NWR conservation corridor and is on one of the main tributaries of Nippersink Creek. This site has a drainage area of 13.6 square miles and includes peak annual flow data from 1962-2015. This provides a more complete picture of peak annual flows for the area compared to the site near Wonder Lake, IL. However, it has a smaller drainage area, so the magnitude of the peak flows are less. The North Branch Nippersink Creek shows a distinct increasing trend over its 54 year record. Peak annual flows range between 39 cfs (2003) and 563 cfs (2000) (Figure 5.4).

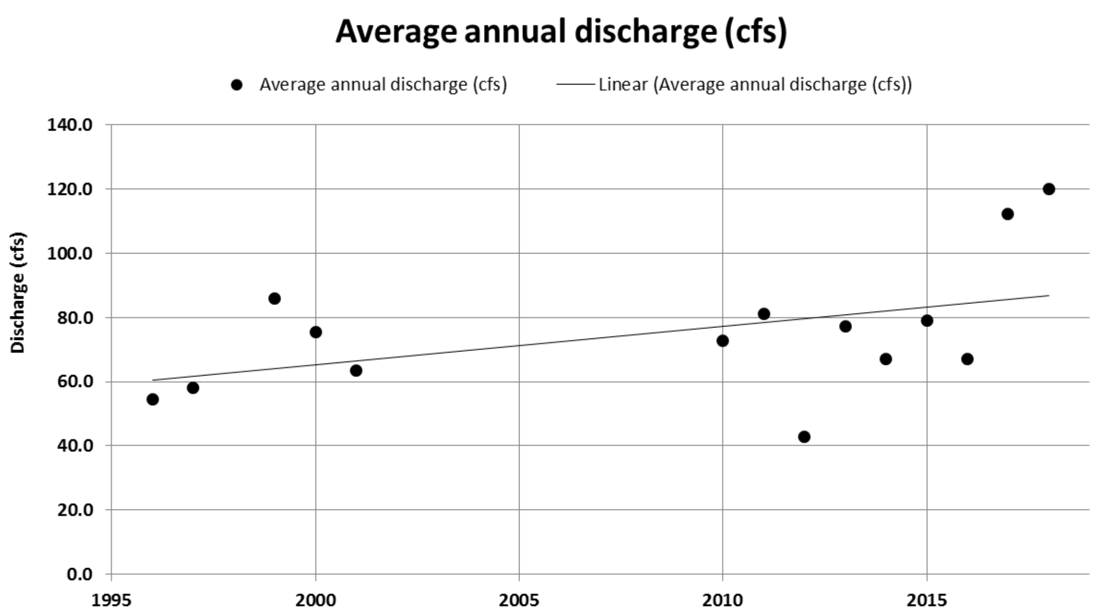


Figure 5.2: Average annual and peak annual discharge (cfs) for USGS-05548105 Nippersink Creek above Wonder Lake, IL (1995-2018)

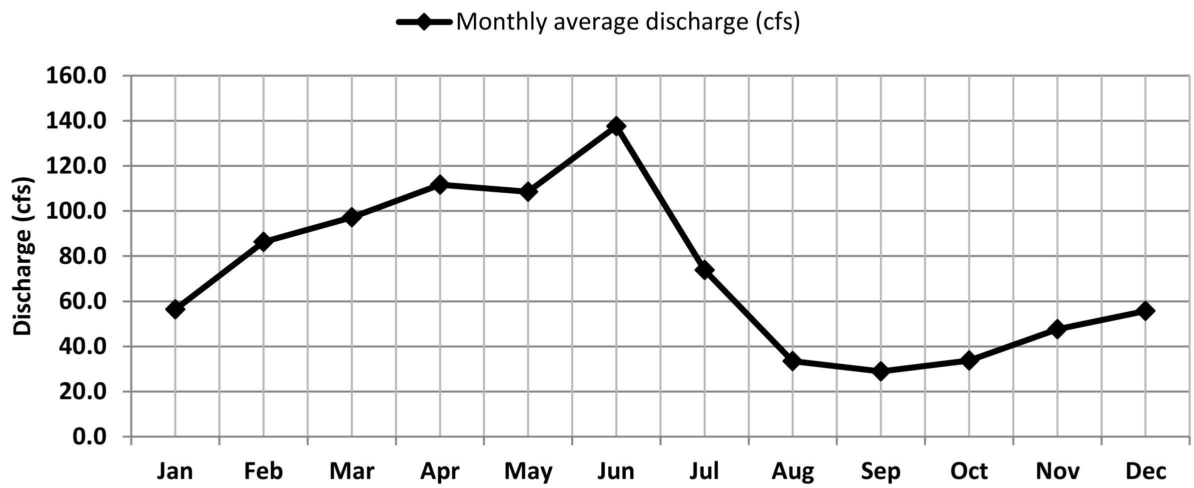


Figure 5.3: Monthly average flow (cfs) for USGS-05548105 Nippersink Creek above Wonder Lake, IL (1995-2018)

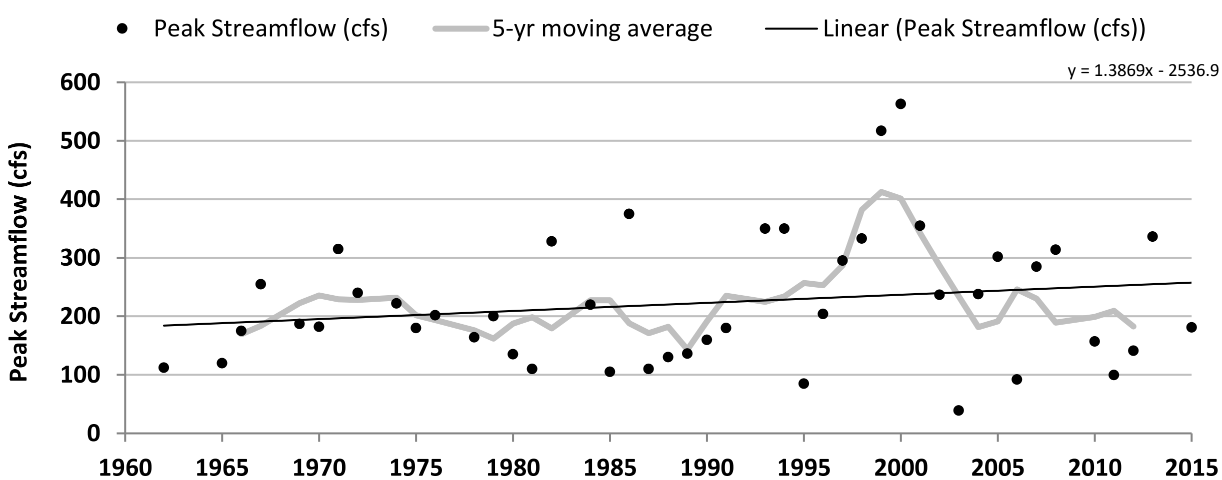


Figure 5.4: Annual peak streamflow (cfs) for USGS-05548150, North Branch Nippersink Creek near Genoa City, WI (1962-2015)

5.3 Hydroclimatic Trends

In addition to gross changes in annual peak and average flows, an analysis of hydrologic climatic data provides additional context for the assessment of surface water quantity patterns. This information can typically be found from the national Hydro-Climatic Data Network (HCDN). The HCDN is a network of USGS stream gages located within relatively undisturbed watersheds, which are appropriate for evaluating trends in hydrology and climate that are affecting flow conditions (Slack et al., 1992, Lins 2009). However, no HCDN gages are found in the area near Hackmatack NWR. As a result, trends in streamflow cannot be attributed specifically to influences from hydroclimate or from landscape alteration and anthropogenic causes. An analysis of the Palmer Hydrologic Drought Index (PHDI) for Northeastern Illinois indicates hydrologic conditions have been predominantly wetter than average for the past ten to fifteen years. This indicates hydroclimatic trends could be contributing to increases in average and peak stream flow, along with contributions from anthropogenic factors.

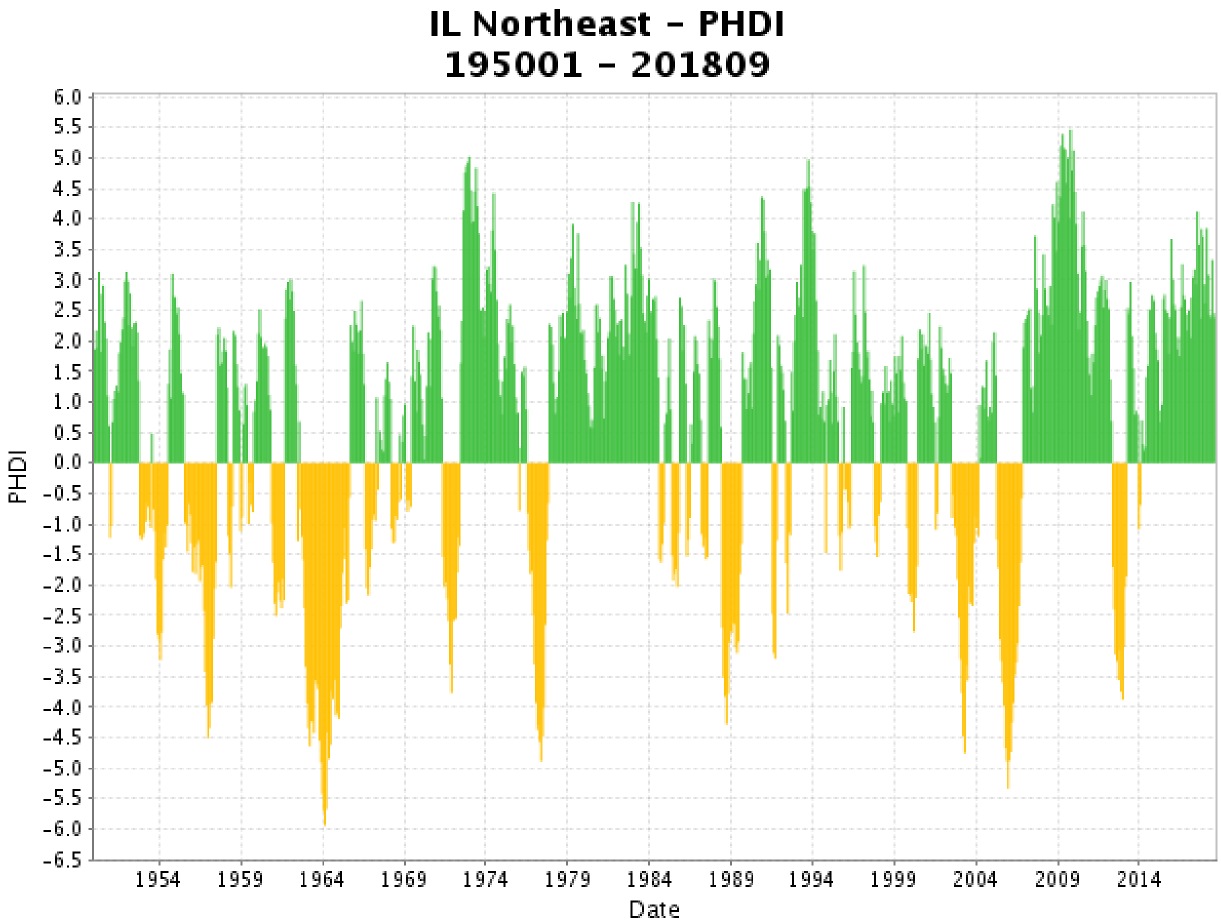


Figure 5.5: Palmer Hydrologic Drought Index (PHDI) of Northeast Illinois from 1950-2018. (Figure from https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp)

5.4 Groundwater Quantity

Groundwater data for this area was available from the USGS-422848088191001 well site, 46N8E-08.2e1, IL. This groundwater well is located just west of the town of Richmond, IL in McHenry County, and falls within the Hackmatack NWR acquisition boundary The well's ground surface is 844.15 feet NAVD88 and is a depth of 24 feet. It's aquifer type is classified as a "*sand and gravel aquifer (glaciated regions)*". There is data from 2009 to present for this site. Annual average depth to groundwater ranges between 6.5 to 8.5 feet (Figure 5.6.), however this fluctuates on a seasonal basis. Monthly average maximum depth to groundwater ranges from as little as 5.1 feet in April to as much as 8.8 feet in October (Figure 5.7). These minimum and maximum groundwater elevations differ slightly from seasonal patterns found in surface runoff for this area (Figure 5.3), where the maximum runoff is found in June and minimum runoff in September.

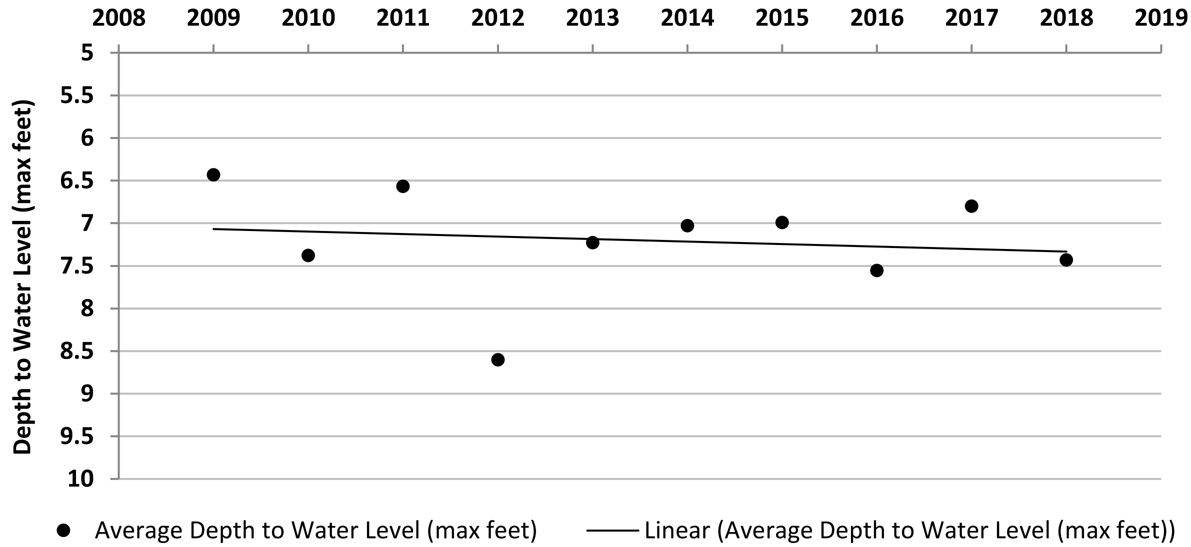


Figure 5.6: Average annual maximum depth to water level (2009-2018) for USGS-422848088191001 well site 46N8E-08.2e1, IL

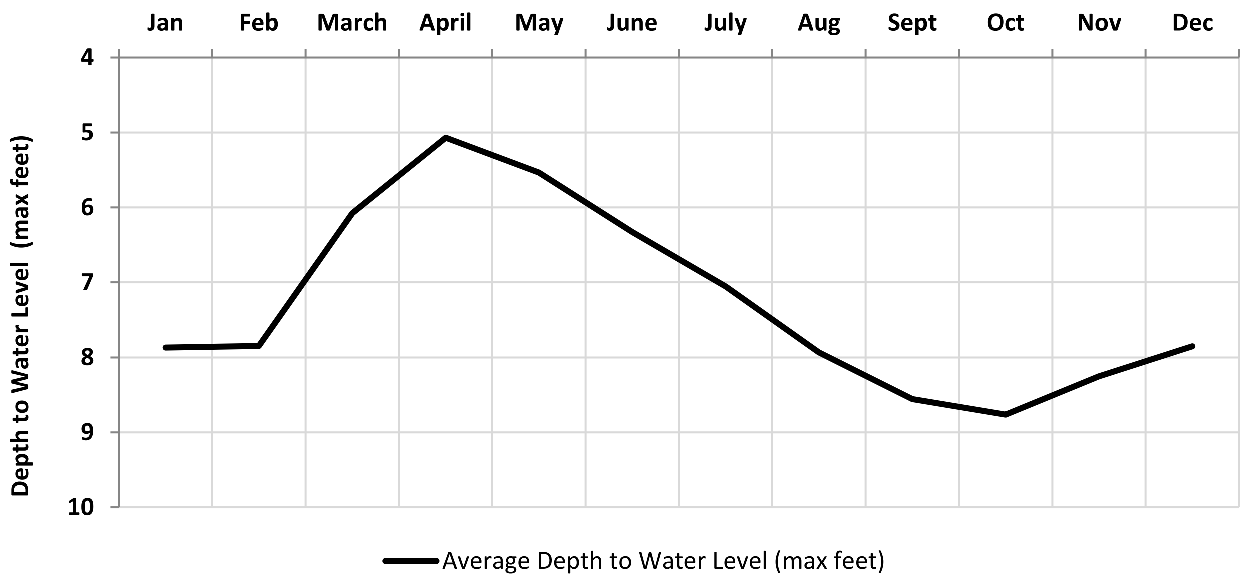


Figure 5.7: Average monthly maximum depth to water level (2009-2018) for USGS-422848088191001 well site 46N8E-08.2e, IL

5.5 Water Quality Criteria

The Environmental Protection Agency (EPA) developed technical guidance manuals and nutrient criteria for the protection of aquatic life in various types of waters specific to different ecoregions. Those developed for rivers/streams and lakes/reservoirs for ecoregion VI and ecoregion VII are summarized below (USEPA 2000; Table 5.2). These criteria are relevant to individual streams and lakes within Hackmatack NWR's RHI.

Additional information related to the application of federal water quality standards and regulations to wetlands is provided by the EPA's Water Quality Standards Handbook (http://water.epa.gov/lawsregs/guidance/wetlands/quality.cfm). Procedures outlined in this handbook are used when specific criteria for wetlands are developed.

Parameter	Ecoregion VI		Ecoregion VII	
	Rivers and Streams	Lakes and Reservoirs	Rivers and Streams	Lakes and Reservoirs
TP (ug/L)	76.25	37.5	33.00	14.75
TN (mg/L)	2.18	0.781	0.54	0.66 (reported)
Chl *a* (ug/L)	2.7 (Fluorometric)	8.59 (Fluorometric)	1.54 (Fluorometric)	2.63 (Fluorometric)
Turb (FTU)	6.36	-	2.32	-
Secchi (m)	-	1.356	-	3.33

Table 5.2: Nutrient criteria for rivers/streams and lakes/reservoirs established for Ecoregion VI (Corn Belt and Northern Great Plains, EPA 2000) and Ecoregion VII (Mostly Glaciated Dairy Region, EPA 2000)

5.6 Surface Water Quality

The EPA has compiled national recommended water quality criteria for roughly 150 pollutants (http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm) to provide guidance in developing state-specific standards. The development of state and federal water quality standards requires consideration of the existing and potential uses of water bodies. Different uses often require different levels of protection for specific pollutants. Water bodies may have several different uses associated with them, such as aquatic life and recreation, in which case criteria for each pollutant are determined based on the most vulnerable designated use (http://water.epa.gov/drink/contaminants/#List). Impairment listings for assessed waterbodies relevant to Hackmatack NWR are discussed below.

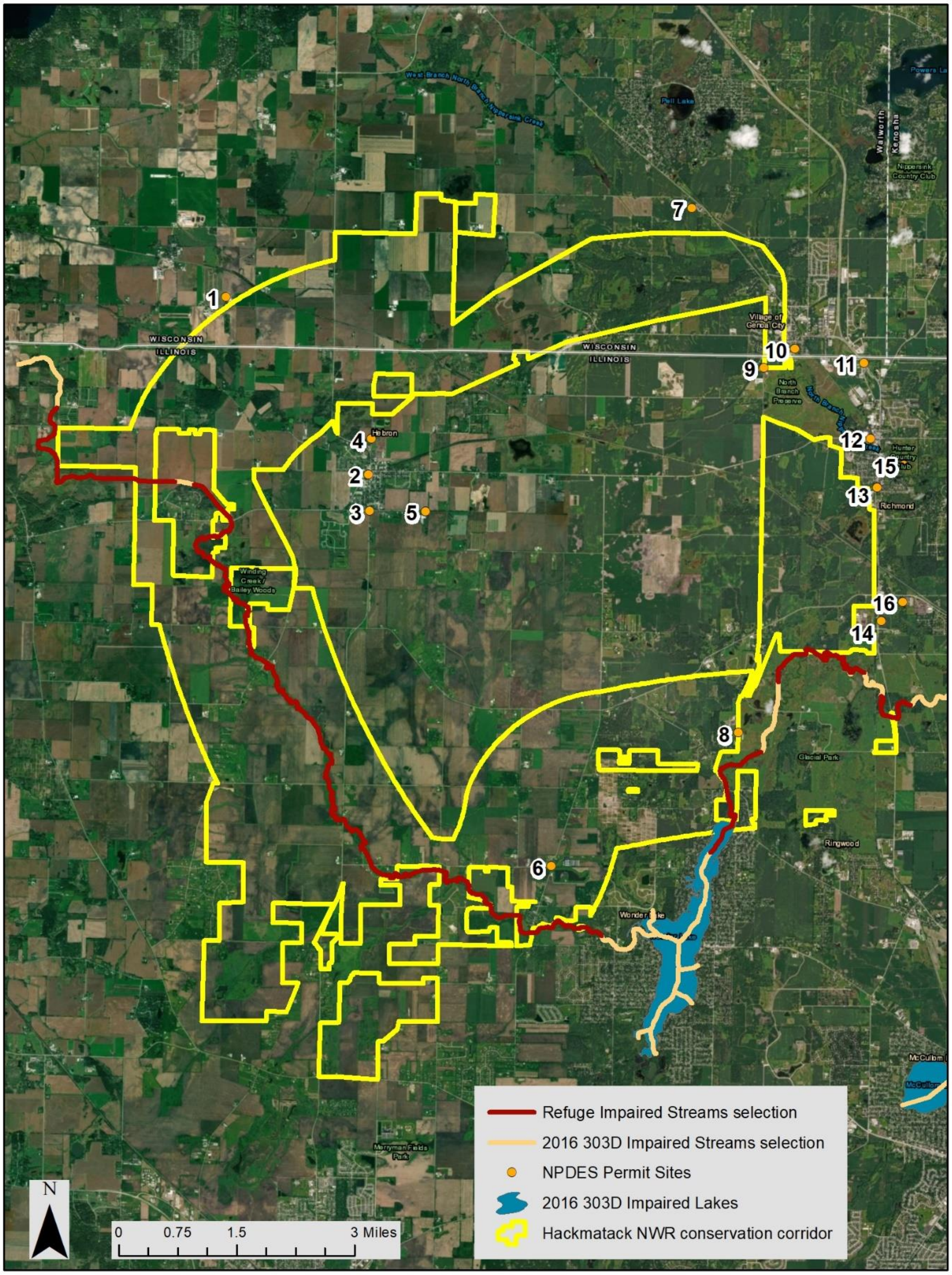


Figure 5.8: NPDES permits and Illinois 303(d) listed impaired waters in proximity to Hackmatack NWR

No.	Permit Facility	Latitude	Longitude
1	MERRY WATER FARMS INC	42.5039	-88.4695
2	HEBRON WWTP, VILLAGE OF	42.4717	-88.4333
3	HEBRON STATE BANK	42.4649	-88.4328
4	HEBRON SUTO SALVAGE	42.4782	-88.4327
5	FILTERTEK, INC	42.4650	-88.4190
6	GAFT AIRPORT	42.4000	-88.3861
7	BLOOMFIELD VILLAGE	42.5217	-88.3538
8	MCHENRY COUNTY CONSERVATION DISTRICT	42.4252	-88.3402
9	KEYSTONE HATCHERIES LLC	42.4925	-88.3353
10	GENOA CITY VILLAGE WWTF	42.4960	-88.3276
11	C AND J MFG AND DIST INC	42.4937	-88.3103
12	WATLOW ELECTRIC MFG CO	42.4797	-88.3084
13	RICHMOND PETROLEUM	42.4707	-88.3065
14	GLENRICH PLAZA LOT 3	42.4461	-88.3050
15	RICHMOND STP	42.4750	-88.3000
16	LEICA BIOSYSTEMS RICHMOND INC	42.4497	-88.2997

Table 5.3: Nearby NPDES permits of potential concern to Hackmatack NWR. NPDES locations obtained from https://www3.epa.gov/enviro/facts/multisystem.html

303(d) Assessments

Section 303(d) of the Clean Water Act requires that each state identify water bodies where water quality standards are not met based on designated usage. Section 303d data from the State of Illinois (2016) were utilized to identify any impaired streams, rivers, or lakes on or in close proximity to Hackmatack NWR. The following table (Table 5.3) lists the water bodies with known designated use(s) impaired, along with the cause(s) of those impairment(s). Figure 5.8 shows the locations of these impaired waters in relation to the Refuge. There are two reaches of Nippersink Creek that fell on the 303(d) list. A portion of Nippersink Creek above Wonder Lake had listed impairments for aquatic life, fish consumption, and primary contact recreation. A portion of the creek below Wonder Lake was listed as impaired for fish consumption and primary contact recreation. These impairments potentially pose a risk to any fish or wildlife at Hackmatack NWR, and as such a priority should be placed on improving watershed conditions. Wonder Lake itself was also listed as impaired for aesthetic quality. However, despite these 303(d) listings, much of the Nippersink Creek watershed is among the highest quality stream resources in northeastern Illinois (USFWS 2012).

Waterbody Name	Assessment ID	Size (Miles)	Designated Impairment(s)	Cause(s)
Nippersink Creek ***(Above Wonder Lake)***	IL_DTK-06	14.90	Aquatic Life, Fish Consumption, Primary Contact Recreation	Aldrin, Nickel, Mercury, PCBs, Fecal Coliform, Unknown Causes
Nippersink Creek ***(Below Wonder Lake)***	IL_DTK-04	4.19	Fish Consumption, Primary Contact Recreation	Mercury, PCBs, Fecal Coliform
Wonder Lake	IL_RTZC	890 (ac)	Aesthetic Quality	Phosphorus (Total)

Table 5.4: Illinois Impaired waters (303(d)) that fall within 0.25 miles of the Hackmatack NWR Conservation Corridor.

Station/River/Lake Water Quality

Water quality data was available from the USGS-05548105, Nippersink Creek above Wonder Lake, IL. This site included data from 1994 to 2014 on numerous water quality parameters. Three parameters were selected for analysis in this report because they either had a long enough period of record or recent enough data that they could be considered relevant to the present state of Nippersink Creek. Total Phosphorus (unfiltered) (TP) was monitored at this location from 1994 to 2001 as a part of a USGS water quality study (Dupre and Robertson 2004). These samples show TP concentrations ranging from 0.03 to as high as 1.10 mg/L, with most samples falling in between the 0.1 to 0.3 mg/L range (Figure 5.9). The EPA recommended nutrient criteria for Ecoregion VI is 0.076 mg/L (Table 5.2), so the creek was often exceeding this threshold from 1994 to 2001. Future water quality sampling efforts should evaluate Total Phosphorus in Nippersink Creek to see if concentrations have decreased, increased, or stayed the same since the 2000's.

Suspended sediment concentrations (mg/L) and loads (tons/day) from 1994 to 2014 vary by several orders of magnitude (Figure 5.10 and 5.11). Elevated sediment concentrations could indicate a threat of aggradation of wetland and floodplain habitats. Periodic monitoring of sediment concentrations would help assess this risk and ensure restorations are designed to adequately mitigate sediment loads. Monitoring could be designed to measure the sediment reduction associated with Refuge land acquisition and restoration activities in Nippersink Creek and its tributaries. A more in depth analysis of past water quality data for the Nippersink Creek Watershed can be found in the 2008 Nippersink Creek Watershed Plan (Watershed Resource Consultants Inc, et al. 2008), and USGS Scientific Investigation Report 2004-5085 (Dupre and Robertson 2004).

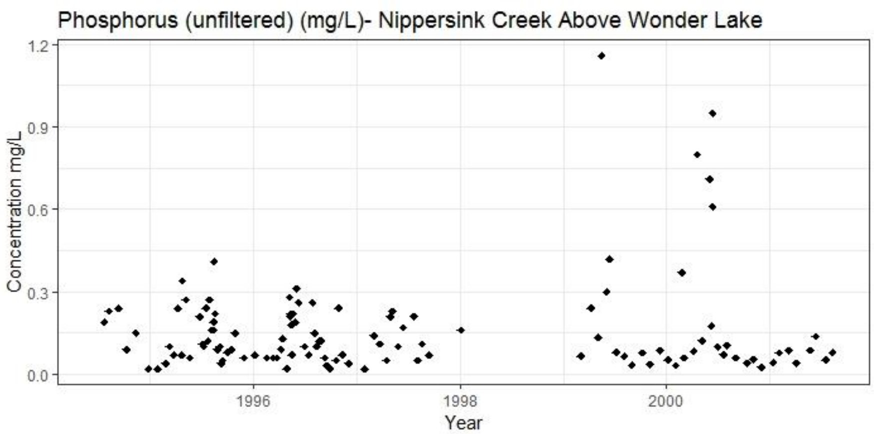


Figure 5.9: Total Phosphorus (unfiltered) (mg/L) for USGS-05548105 Nippersink Creek above Wonder Lake, IL

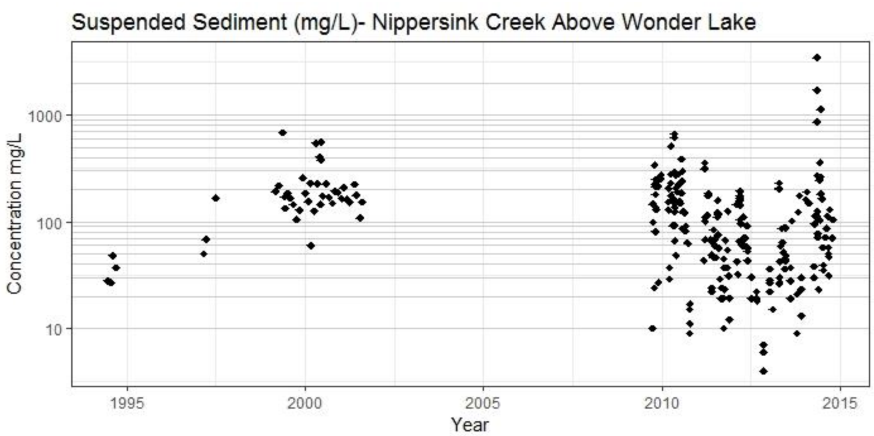


Figure 5.10: Suspended sediment concentration (mg/L) for USGS-05548105 Nippersink Creek above Wonder Lake, IL (1994-2014).

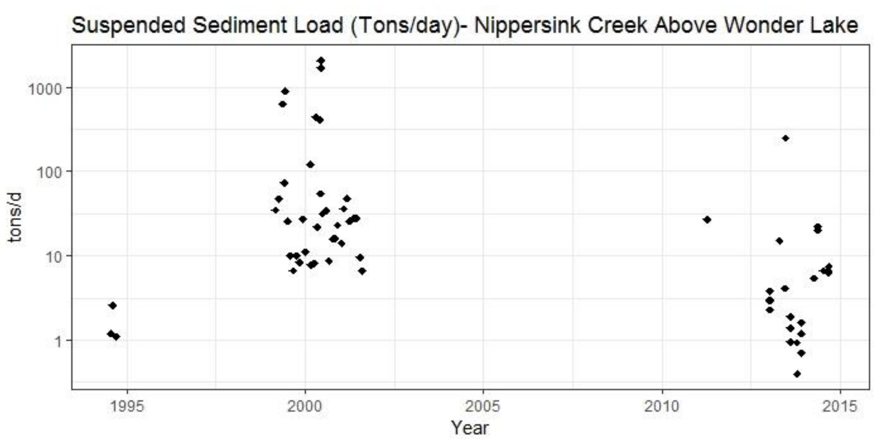


Figure 5.11: Suspended sediment load (tons/day) for USGS-05548105 Nippersink Creek above Wonder Lake, IL(1994-2014).

5.7 Groundwater Quality

Some groundwater quality data is available for the area at USGS well 46N8E-08.2e1, IL, mentioned in section 5.4 (USGS-422848088191001). The data at this site includes continuous water temperature measurements from 2015 to 2016 and specific conductance measurements from 2011 to 2016. The temperature data for this site follows a distinct seasonal albeit lagged fluctuation (Figure 5.12) ranging from as high as 12.7 C to as low as 8.7C. The period of highest temperatures appears to be in November, and the period of lowest temperatures appears to be in April. Conductivity appears to be much more variable on both an annual and intra-annual basis. Overall, the groundwater conductivity appears to be showing an increasing trend. However, on a year-to-year basis, it varies quite a bit as can be seen in Figure 5.13. The years 2011 and 2012 show an increasing trend, but then 2013 and 2014 show a significant decrease. 2015 and 2016 show the highest recorded levels. There also appears to be a significant drop most years around March, possibly correlating with snowmelt and spring precipitation infiltrating to the groundwater table. There are five Class III Special Resource Groundwater Protection Areas in McHenry County (USFWS 2012). These areas were established to preserve aquatic communities dependent on groundwater from shallow aquifers.

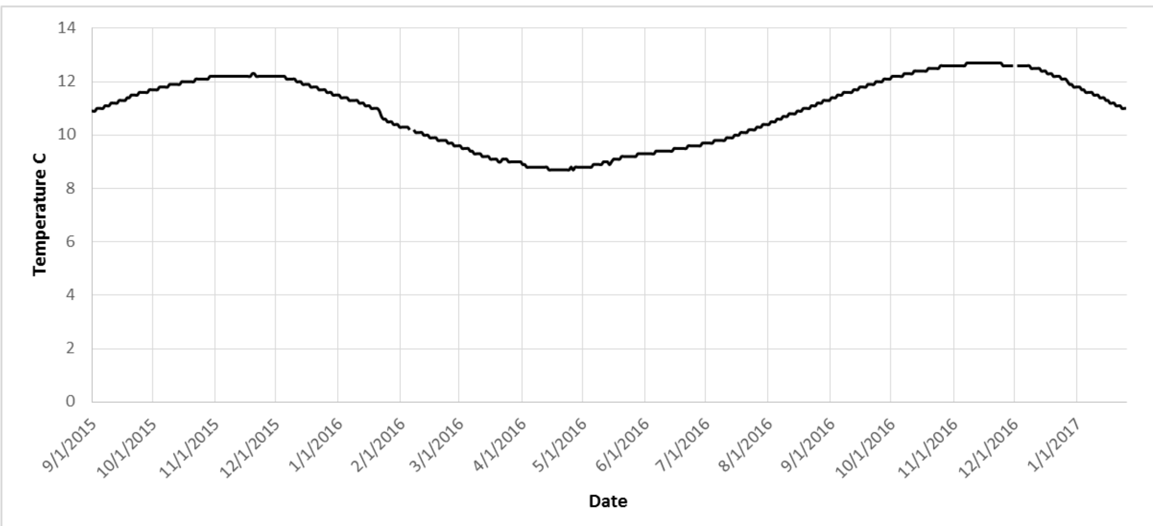


Figure 5.12: Groundwater daily average temperature (2015-2016) for USGS-422848088191001 well site 46N8E-08.2e, IL.

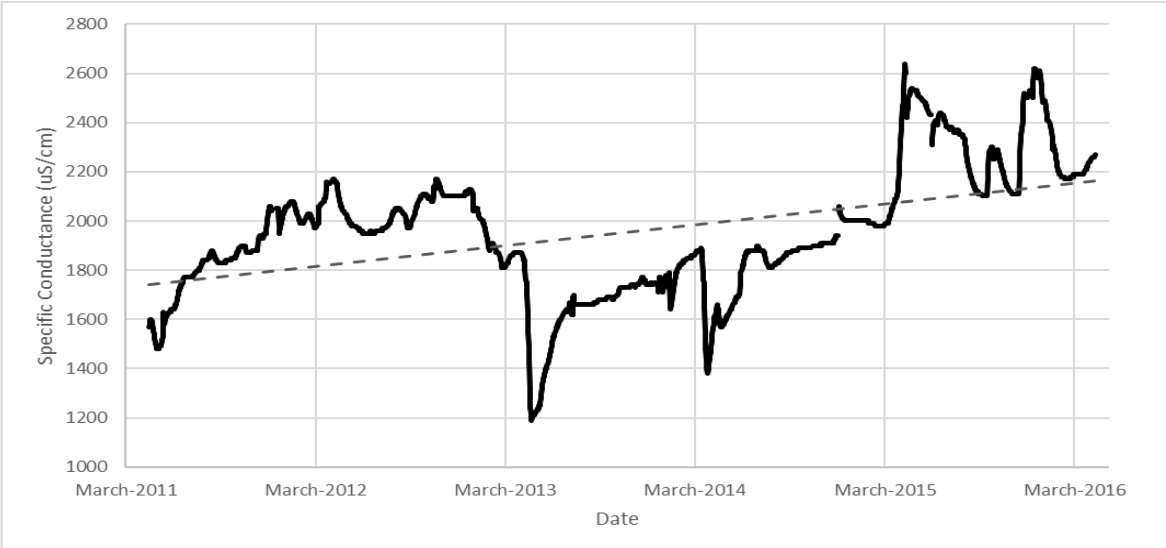


Figure 5.13: Groundwater daily average specific conductance (2011-2016) for USGS-422848088191001 well site 46N8E-08.2e, IL

Chapter 6: Water Law

Wisconsin

Wisconsin follows a "regulated riparian" legal model which means the state relies on some common law principals and some legislatively designed programs, creating a hybridized water-law scheme. The state still uses a common law reasonable-use rule that matches the traditional rule across riparian states. When determining whether a riparian owner is using water in a reasonable manner, courts look at each issue on a case-by-case basis.[1] However, the state courts have identified many factors to help guide the analysis. Specifically, the "subject matter of the use, the occasion and manner of its application, its object, extent and the necessity for it, to the previous usage, and to the nature and condition of the improvements upon the stream; and so also the size of the stream, the fall of water, its volume, velocity and prospective rise and fall, are important elements to be considered."[2] The state courts in *State v. Michaels Pipeline Construction, Inc.* changed the common law with regard to groundwater by bringing groundwater under the same reasonable-use analysis as surface water.[3]

As in other riparian states, riparian landowners cannot infringe upon public rights on navigable waters.[4] The public's water right includes the right to navigation, to fish, and, rather uniquely, to the enjoyment of natural scenic beauty.[5]

The portion of the common law that Wisconsin replaced with statute relates to water withdrawals and diversions. The state courts have identified these statutes as having "the result of introducing an element of prior use into the Wisconsin water law," but they are to be strictly

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[1] *Sterlingworth Condo. Ass'n v. Dep't of Nat. Resources*, 205 Wis. 2d 710, 731 (Wis. Ct. App. 1996).
[2] *Timm v. Bear*, 29 Wis. 254, 255 n.3 (Wis. 1871).
[3] 63 Wis. 2d 278 (Wis. 1974).
[4] *State v. McFarren*, 62 Wis. 2d 492, 499 (Wis. 1974).
[5] *Muench v. Public Service Comm'n*, 261 Wis. 492 (Wis. 1952).

construed to the narrow purpose for which they were enacted.[6] This means that in instances where the withdrawal and diversion statutes apply, a permit is analogous to ownership of a riparian right to use and vice versa—without a permit, a person does not have a riparian right to the use.[7]

The permit program applies to withdrawals from streams for agriculture, irrigation, and maintaining lake water levels,[8] and it applies to both streams and lakes for large-scale diversions, meaning diversions of two million gallons-per-day during a 30-day average and 100,000 gallons-per-day if diverting water from a Great Lakes basin to a location outside.[9] As a result of old statutes from the Nineteenth Century, cranberry bogs are specifically exempt from these regulations.[10] Applications for a permit must contain very detailed information about the project itself and data about the withdrawal.[11] Additionally for large-scale diversions, applicants must determine an alternative water source, anticipate effects on the Great Lakes basin or Mississippi River basin, and describe the conservation measures the applicant will implement.[12] If the withdrawal is from a stream for agriculture or other type of irrigation, the application must include "written statements of consent to the withdrawal from all riparian owners who are making beneficial use of the water proposed to be withdrawn."[13]

DNR will only approve a permit for a large-scale diversion after notice to the public and a hearing if (1) the diversions do not injure public rights, and (2) either the water diverted is "surplus water," or if not, the other riparian landowners consent to the diversion.[14] "Surplus water" means any "water of a stream that is not being beneficially used[;]" this determination is made by DNR.[15] Once issued, DNR will review the permit no less than once every five years, and permittees must annually report its volume and rate of withdrawal and water loss.[16] DNR can revoke the permit if the water level drops below the surplus level, or if the agency finds that the diversion is "detrimental to the stream."[17] If the stream is given "trout designation" (discussed below) by DNR, then the agency may revoke for conservation purposes.[18] For groundwater, DNR requires a person to obtain a permit before drilling a well with the ability to

[6] *Omernick v. Dep't of Nat. Res.*, 71 Wis. 2d 370, 373 (Wis. 1976); *State* ex rel. *Chain O' Lakes Protective Ass'n v. Moses*, 53 Wis. 2d 579, 583 (Wis. 1972).
[7] *Id.*
[8] Under its delegated authority, DNR may also raise streams and lakes for conservation purposes through diversions or other means. Wis. Stat. Ann. § 30.18(8).
[9] Wis. Stat. Ann. § 30.18. The provision relating to diversions outside of Great Lakes basins results from the Great Lakes Basin Compact, which was discussed in more depth in the "Michigan" section.
[10] Wis. Stat. Ann. § 94.26.
[11] Wis. Stat. Ann. § 30.18(3)(a)
[12] Wis. Stat. Ann. § 281.35(5)(a).
[13] *Id.*
[14] Wis. Stat. Ann. § 30.18(5).
[15] Wis. Stat. Ann. § 30.01(6d).
[16] Wis. Stat. Ann. § 30.18(6).
[17] Wis. Stat. Ann. § 30.18(5).
[18] *Id.*

withdraw 100,000 gallons-per-day.[19] Groundwater permits must not adversely impact or reduce the supply of public utilities.[20]

The state also implemented numerous permit programs regarding structures in the water.[21] Dam permits require compliance with many more provisions, including a requirement that at least 25% of the stream's natural flow passes through the dam at all times.[22] All permit programs look to one standard, however: whether the structure will impact the public rights discussed above.[23]

DNR has the responsibility of classifying lakes and streams as part of its fishery resource management duties. First, DNR determines which streams are fish refuges for the purpose of securing "the perpetuation of any species of fish and the maintenance of an adequate supply thereof."[24] This duty requires DNR to regulate private and commercial fisheries, manage state fish refuges, and propagate fish resources through state hatcheries.[25] Within the fish refuges, it is illegal to "take, disturb, catch, capture, kill or fish for fish" in any manner or any time.[26] The state has designated numerous areas throughout the state as refuges which can be found in the state Administrative Code.[27] Second, the DNR can give certain streams "trout designation" and then classify those streams within a range from Class I to III, with Class I streams containing a self-sustaining trout population, among other characteristics. Such designation has the effect of adding an extra layer of DNR approval before withdrawal or diversion permits, discussed above, are issued.[28]

At a regional level, as a state between many important interstate an intercontinental water bodies, Wisconsin participates in the Great Lakes Basin Compact, the Council of Great Lakes Governors, and interstate agreements that protect the Boundary Waters and the Mississippi River.[29] While instream flows do not have a strong presence in Wisconsin water law, many of the measures the state has taken to protect its fishery resources work in tandem with the goals of FWS.

Illinois

Illinois does not have a sophisticated means for claiming rights to water, especially for instream water rights. As a state that generally follows the traditional riparian rights doctrine,[30] all landowners adjacent to a body of water have a right to reasonable use of the water, so long

[19] Wis. Stat. Ann. 281.17.
[20] *Id.*
[21] Wis. Stat. Ann. §§ 30.12–30.16, 30.19–30.20
[22] Wis. Stat. Ann. § 31.34.
[23] *See, e.g.*, Wis. Stat. Ann. § 13.12.
[24] Wis. Stat. Ann § 23.09(2)(c).
[25] Paul G. Kent & Tamara A. Dudiak, *Wisconsin Water Law: A Guide to Water Rights and Regulations* 71 (University of Wisconsin-Extension, 2d ed., 2001).
[26] *Id.*
[27] Wis. Admin. Code § 26.01 *et seq.*
[28] *Omernick v. Dep't of Nat. Res.*, 71 Wis. 2d 370, 373 (Wis. 1976).
[29] Kent & Dudiak, *supra* n.235 at 27–28.
[30] *Evans* v. *Merriweather*, 4 Ill. 491 (1842); *Knaus v. Dennler*, 525 N.E.2d 207, 209 (Ill. App. Ct. 1988).

as it does not impact the same rights as other similarly situated landowners.[31] The legislature codified surface and ground water into one system under the Water Use Act of 1983, which extended the common law reasonable-use rule to groundwater withdrawals.[32]

The statute specifically defined "reasonable use," in keeping with the common law, as "the use of water to meet natural wants and a fair share for artificial wants. It does not include water used wastefully or maliciously."[33] In Illinois, "natural wants" refer to uses necessary to the land, mainly domestic uses.[34] "Artificial wants," on the other hand, refer to uses that would increase "comfort and prosperity."[35] In times of shortage, the state will prioritize natural wants over artificial wants, and once natural wants are satisfied, water users may consume their "just proportion" of artificial wants.[36] Courts ultimately determine on a case-by-case basis whether a water user has consumed beyond his "just proportion," looking at the relative needs of the water users and the water availability.[37]

With the reasonable-use rule as a foundation, Illinois allows communities to regulate groundwater consumption through the establishment of water authorities, in order to give communities the power to take control of their local resource. The Water Authority Act (WAA) sets out a detailed and extensive procedure for citizens to create a water authority, but once established, the local authority has broad powers.[38]

At least thirteen water authorities have been established since the law was enacted, mostly in the eastern-central part of the state.[39] However, the WAA specifically excludes water used for agricultural purposes, irrigation, and small domestic wells for less than four families from the Authorities jurisdiction.[40] The law does not provide any specific authority for water authorities to ensure minimum flows or instream uses, but at least provides a broad catchall, allowing authorities to "make such regulations as it deems necessary to protect public health, welfare and safety and to prevent pollution of its water supply."[41] This may be the only provision FWS could rely upon to protect instream flows within a local water authority region.

In addition to the local water authorities, the Illinois Department of Natural Resources (DNR) has jurisdiction over public waters, and the agency has a duty to document all navigable waters and "jealously guard the true and natural conditions" of state waters.[42] Under this policy, DNR's Office of Water Resources manages a permit system for construction projects in public

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[31] Gary R. Clark, *Illinois Groundwater Law: The Rule of Reasonable Use* 14–15 (State of Illinois, Department of Transportation and Division of Water Resources 1985).
[32] Water Use Act of 1983, 525 Ill. Comp. Stat. 45/6 (2011).
[33] 525 Ill. Comp. Stat. 45/4.
[34] *Evans* v. *Merriweather*, 4 Ill. 491, 495 (1842).
[35] *Id.*
[36] *Bliss v. Kennedy*, 43 Ill. 67, 74 (1867).
[37] *Id.* at 76–77.
[38] 70 Ill. Comp. Stat. 3715/1 *et seq.* (2011).
[39] *See* http://www.isws.illinois.edu/docs/wsfaq/wsmore.asp?id=q6; http://www.agr.state.il.us/marketing/IALD/organizations/IALDDirectory%2058.pdf.
[40] 70 Ill. Comp. Stat. 3715/8 (2011).
[41] 70 Ill. Comp. Stat. 3715/24 (2011).
[42] 615 Ill. Comp. Stat. 5/5 (2011).

water ways, i.e. navigable waters, and for public water developments that may impact public rights to use the water.[43]

In Illinois, FWS has a right to the reasonable use of surface and ground water associated with the boundaries of the refuges. While FWS cannot affirmatively assert its right to instream use, it may have a claim against other water users if a shortage occurs, even if that right consists of a just proportion of its natural wants.[44] However, these issues have yet to be explored by the courts.

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[43] Ill. Admin. Code tit. 17 §§ 3700, 3704, 3708 (2010).
[44] Illinois courts have not spoken on whether instream uses for fish and wildlife purposes would constitute a natural want.

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Appendix A: Threats and Needs Table

The following data will be uploaded into the national ECOS WRIA database.

Threats

Title	Threat Type	Threat Cause	Threat Status	Severity	Immediacy	Quality
Urban Storm Runoff	Altered Flow Regimes	Urban Runoff	Future	High	Medium-Term	High
Urban storm runoff water quality	Other Contaminants/ Altered Water Chemistry	Urban Runoff	Future	High	Medium-Term	Medium
Urban storm runoff water quality	Salinity/TDS/Chlorides/Sulfates	Urban Runoff	Future	Moderate	Medium-Term	Medium
Urban water quality	Nutrient Pollution	Wastewater Treatment Facilities	Future	Moderate	Medium-Term	Low/Unknown
Exisitng infrastructure or drainage agreements	Compromised Water Management Capability	Other Legal/Political Constraints	Future	Low	Medium-Term	Low/Unknown
Increased Precipitation	Excess Surface Water	Change in Frequency/Severity of Extreme Precipitation Events	Future	Moderate	Long-term	High
Climate warming	Habitat Shifting/Alteration	Climate Warming	Future	Moderate	Long-term	High
Nippersink Creek Water Quality	PCBs	Urban Development	Current	Moderate	Existing	Medium
Nippersink Creek Water Quality	Pesticides	Agriculture	Current	Moderate	Existing	Medium
Point Source Pollution	Endocrine Disruptors/Emerging Contaminants	Industrial Effluent	Current	Moderate	Medium-Term	Low/Unknown
Groundwater Quality	Salinity/TDS/Chlorides/Sulfates	Urban Development	Current	Unknown	Existing	Low/Unknown
Wonder Lake	Compromised Water Management Capability	Other Legal/Political Constraints	Current	Low	Existing	Low/Unknown

Needs

Title	Level 1 Type	Level 2 Type	Status	Priority	Effort Required	Immediacy	Feasibility	Quality
Watershed BMP's and water quality	Water Quality Mitigation/Habitat Improvement	Reduce Non-Point Source Pollution	Current	High	Major	Short-term	Yes	High
Comprehensive wate quality analysis	Monitoring / Measurement	Water Quality Baseline Monitoring	Current	High	Minor	Short-term	Yes	High
Hydrologic assessment of new parcels	Modeling / Research / Assessment	Fluvial Geomorphic Assessment(form and function)	Future	Low / Unknown	Minor	Medium	Yes	Low/Unknown
Review of NPDES Permits	Modeling / Research / Assessment	Water Quality Concentration/Loading Assessment	Current	Moderate	Minor	Short-term	Yes	Medium
Watershed partnerships and restoration	Coordination / Support	Build/Strengthen/Expand Watershed Partnerships	Current	High	Minor	Short-term	No	High
Sustainable restoration planning	Water Quality Mitigation / Habitat Improvement	Restore floodplain function	Current	High	Minor	Short-term	Yes	Medium
Sustainable restoration planning	Modeling / Research / Assessment	Climate Change Vulnerability Assessment	Current	High	Minor	Short-term	Yes	Medium

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